THE JOURNAL OF DENTAL RESEARCH

(Continuing the Journal of the Allied Dental Societies)

A journal of stomatology; devoted to the advancement and dissemination of knowledge pertaining to the teeth and mouth, and to their relations to the body as a whole

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DELAY IN THE PUBLICATION OF THIS VOLUME

The numbers of this Volume were issued during the period from February to November, 1925. The reasons for the unavoidable delay were stated to the subscribers in a circular letter in December, 1924.

DISCONTINUANCE OF THE ABSTRACTS OF THE CONTENTS

Beginning with this Volume the abstracts of the contents, heretofore grouped after the table of contents, will be discontinued. If 10 per cent of the number of subscribers request their continuance, the abstracts will be presented as heretofore.

REPORT ON THE ENDOWMENT FUND OF THE JOURNAL OF DENTAL RESEARCH

In order to avoid repetition at short intervals, in view of the early prospective issuance of the next two volumes, the list of contributors to the Fund since December, 1922, will be published in the volume for 1925.

PROCEEDINGS OF DENTAL SOCIETIES NOW PUBLISHED AS INDEPENDENT JOURNALS WITHIN THE JOURNAL OF DENTAL RESEARCH

Affiliated dental societies now publish their Proceedings on conditions that make each Society's group of papers, in effect, its own independent journal under the covers of the Journal of Dental Research. Sections may be obtained as reprints for issuance in separate volumes of Transactions. The broad import of this development for the cause of independent professional journalism will become apparent as it evolves in the successive issues.

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STUDIES OF FUSIFORM BACILLI AND SPIROCHAETES

VIII. Their Occurrence in Alveolar Abscesses

D. J. DAVIS, M.D., Ph.D., and F. B. MOOREHEAD, D.D.S., M.D.

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INTRODUCTION

Observations have been going on in our laboratory for some time upon the distribution of fuso-spirochaete organisms in the body and on lesions in which they are found. As a result of these studies it seemed that inasmuch as one of the most important localities in which these organisms are often found normally is on and about the teeth, and since they are associated with many buccal lesions, it would be reasonable to expect them to occur often and possibly play an important rôle in alveolar lesions, especially the purulent and necrotic ones. We have already shown the significance of these bacteria in a variety of conditions including pulmonary gangrene, buccal lesions, genital lesions, etc. (3), and have called attention to their importance in determining the character of the lesion and to their association with pyogenic bacteria, particularly streptococci. In this paper we wish to emphasize this association of bacteria as a factor in determining the character and progress of lesions of this type in connection with alveolar abscesses.

In the literature several papers have appeared on the bacteriology of alveolar abscesses. The first paper of importance is that by Gilmer and Moody (5), who found in a series of some forty cases the Streptococcus viridans as the predominating organism in the exudate, and which they regard as the chief cause. They also state that "the anaerobic cultures which do contain streptococci are rarely pure. Some contain Bacillus fusiformis in varying numbers, a few of these tubes however have practically pure cultures of fusiform bacilli." They have emphasized (4) also the occurrence of putrefaction processes in alveolar abscesses in association with the activities of pyogenic cocci,

and speak of symbiosis of organisms as existing in certain cases and intensifying or modifying the process. In addition to streptococci, in periapical tissues or at the apex, Collins and Lyme (1) noted the presence of B. fusiformis, alone at times but usually associated with spirochaetes. They considered that a variety of organisms must be considered in determining the etiology of periapical and pulp infections. The work of Hartzell and Henrici (6) centered largely around the Streptococcus viridans as the cause of alveolar abscesses. In a later review (7) they state that fusiform bacilli are frequently found in chronic alveolar abscesses but not constantly, and conclude that these organisms are mere "camp followers, harmless putrefactive germs living on tissues killed by more pathogenic microörganisms."

It is evident that although the fusiform bacilli and spirochaetes have often been seen associated with streptococci in alveolar abscesses, their presence has been regarded by different observers, with the exception of Gilmer, as more or less incidental, the process being chiefly due to the streptococci.

From studies made of lesions in other parts of the body we are of the opinion that while the pyogenic cocci are the more aggressive, the association with these two organisms is of real importance in determining the character and course of the process, and should not be dismissed as organisms of no consequence. Our experimental work, for example, has shown that a lesion caused by pure streptococcal infection is a very different affair from one produced by streptococci plus fusiform bacilli and spirochaetes. The early reports of Gilmer and Moody (5) are evidently in accord with this point of view.

On practically all teeth fusiform bacilli and spirochaetes and cocci, along with leptothrix threads, occur in large numbers in the bacterial masses or granules growing constantly about the gingival margin. One of the first problems, therefore, in the bacteriological study of the exudate at the terminus of a tooth would be the matter of obtaining it uncontaminated by the surrounding organisms. Upon this point great emphasis is placed.

The teeth involved in this study were removed under novocain anaesthesia by the following method: The tooth and surrounding tissue were swabbed freely with 50 per cent alcohol followed by searing the gum tissue with a hot spatula. After the tooth was removed the

mouth of the wound was again seared and a platinum loop introduced into the socket. Where the granuloma remained attached to the root it was opened with a hot spatula and a smear taken from the interior. When the granuloma remained in the socket it was carefully removed by a small currette. Preliminary smears were made from the surface of the gum tissue and tooth previous to the extraction. These, compared with the smears taken from the socket, offer abundant proof of the differential bacteriology of the two fields.

Twenty cases of alveolar abscess have been investigated. They were practically all chronic in course and were diagnosed by x-ray examinations. In all cases indications were clear for the removal of the teeth either because of local or general lesions.[1]

In the twenty cases (see the table on page 4), in smear preparations, gram-positive cocci chiefly as diplococci or short chains were seen. They all appeared identical and had the morphology of a streptococcus, which in many of the cases was proved by culture. They were usually in moderate numbers. In all cases without exception were also seen curved gram-negative pointed bacilli of the fusiform type, usually quite numerous. In two cases they were few; in seven they were only in moderate numbers. Often they contained typical granules. In one instance in the pus was seen a stellar arrangement of fusiform bacilli suggesting actinomyces-like forms that are occasionally seen in fusiform lesions, and to which special attention has been given by Coronim and Preizel (2). In the smear preparations, too, are commonly seen long thread forms, often curved and with or without pointed ends. We are not certain whether or not they belong in the fusiform group.

Staphylococci were found in only a few instances, were always few in numbers in plate cultures, and apparently of little or no importance in most specimens. In sixteen of twenty cases spirochaetes were found (see the accompanying illustration). Here again they were usually numerous. In six they were relatively few. In the four instances in which they were not found at all after a long search, the fusiform bacilli were not in large numbers. The cocci in these cases were quite numerous. Whether these relative values have any significance is not known.

[1] The patients investigated were all in the hospital suffering from chronic infections in one form or another.

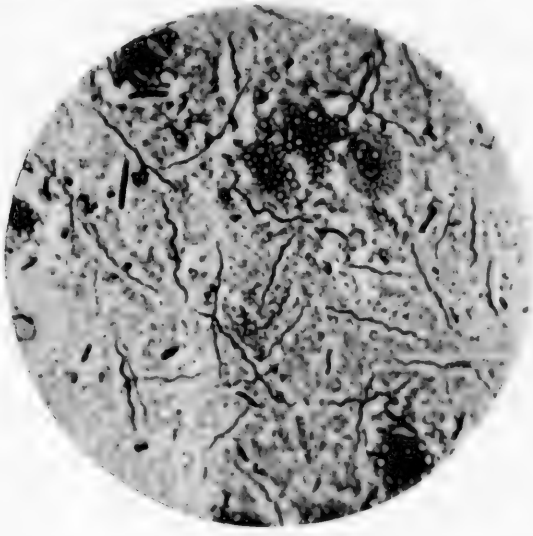
Bacteriological results in cases of alveolar abscess

CASE NUMBER	BACTERIA			NOTES
	B. fusiformis	Spirochaete	Cocci	
1	++	++	++	Aerobic cultures yield pure S. viridans. Anaerobic cultures: B. fusiformis and S. viridans
2	+	0	+++	Aerobic culture gave nearly pure S. viridans. Levaditi stain of root granuloma negative for spirochaetes
3	+	+	+	Pus cells in moderate members. Very few bacteria
4	++	++	++	Control smears yield very few bacteria
5	+++	++	+	In control smears, few spirochaetes and fusiform bacilli found
6	++	+++	++	In controls very few organisms
7	+++	+++	+ (Few bacilli)	In controls few bacteria. Very few fusiform bacilli in smears
8	+++	+++	++	A moderate number of small unidentified bacillus in direct smear preparations
9	+++	++	++	
10	++	++	++	In aerobic culture pure S. viridans. In anaerobic culture many fusiform bacilli and cocci
11	+++	0	+++ (Few bacilli)	Aerobic cultures give pure S. viridans. Anaerobic cultures yield streptococci and fusiform bacilli
12	++	+++	++	In smears were radiate and brush-like forms
13	++	0	+	Aerobically pure S. viridans
14	+++	+++	++	Organisms very numerous
15	++	++	+	
16	++	+++	++	In aerobic cultures pure S. viridans. Anaerobically, fusiform bacilli and streptococci
17	++	++++	+	
18	++	++	++	Control smears reveal very few bacteria
19	+++	+++	++	Controls reveal very few organisms
20	+++	+++	++	In control smears few spirochaetes, bacilli and cocci

All the patients were in the hospital suffering from a form of chronic infection.

In many of the cases material for tube and plate cultures was obtained. It was noteworthy that in seven in which it was possible to obtain material for aerobic plates a practically pure growth of Streptococcus viridans was obtained. These blood plates were very striking. In the anaerobic cultures of the same cases, without exception, a profuse growth appeared consisting of streptococci and fusiform

bacilli and giving off the characteristic odor in all. This was also true in those cases that showed no spirochaetes in smear preparations. In several of the anaerobic blood tubes the growth became fluorescent purple or almost black, evidently due to a peculiar transformation of blood pigment. It was noted that the streptococci grew more profusely in anaerobic than in aerobic plates. This is in conformity with observations made by Pilot and Davis (8) on streptococci from tonsil crypts and those of Gilmer and Moody (5) in alveolar abscesses.



SMEAR PREPARATION FROM APICAL ABSCESS SHOWING COCCI, SPIROCHAETES, AND LONG AND SHORT FORMS OF FUSIFORM BACILLI. 1200 DIAMETERS

Since so many bacteria similar to these occur in the mouth about the gingival margin, the possibility of contamination of the smear preparations was always kept in mind. In addition to the precautions already noted, control smears were made from the surface parts of the teeth adjacent to the margin where such organisms are most apt to exist. In ten such control smear preparations, made in the same way as those from the apical region, both fusiform bacilli and spirochaetes were usually found. In two, spirochaetes could not be found. However, in all, the bacteria were decidedly less numerous than in the

apical smears. This fact would seem to indicate very clearly that the bacteria found in the apical area were not contaminations from the adjacent parts of the tooth.

A histological study of the tissues was not attempted but notes were made of the cellular content of the smears. In all the preparations pus cells were seen; usually they were quite numerous, though few in some specimens. Polynuclear cells were predominant as a rule. In some smears large mononuclears were fairly numerous. In two instances small granulomas attached to the end of the tooth were examined by Levaditi stain. No spirochaetes were seen in these preparations, though they contained cocci and bacilli. They were composed of chronic granulation tissue.

The material from the apical region is apparently foul smelling and putrid, though this is at times difficult to determine with certainty since other parts of the tooth may be putrid also. From the appearance of the material and the smear preparations, it is evident that there is also softening of a gangrenous or putrid character. Streptococcus viridans alone is ordinarily not a pus producer and does not cause putrid abscesses. The contents of these lesions, therefore, would clearly indicate that they have the characteristics of a putrid gangrenous process such as is found generally as a result of a coccal fuso-spirochaete infection.

DISCUSSION

In relatively few conditions can fusiform bacilli and spirochaetes be considered primarily pathogenic. They seem to become at times quite highly virulent and are able to attack tissues primarily, as in outbreaks of Vincent's angina. Usually however they appear as opportunists, living in various parts of the body; and only when tissues become altered by vascular changes, infection by more highly virulent organisms, anemia, diet-deficiency disease, trauma, excessive irritation, foreign bodies, etc., do they invade the weakened tissue and cause characteristic changes. This statement would seem to be abundantly justified when one considers such striking lesions as noma, pulmonary gangrene, putrid bronchitis and bronchectasis, putrid empyema, putrid otitis media, gangrenous balanitis, etc.

However, we should avoid the conclusion that, because an organism is not primarily pathogenic, it is of no importance in pathological processes. As a matter of fact relatively few organisms are primarily pathogenic in the sense that they will attack or invade a perfectly normal person. Streptococci, for example, usually do not do so except when of high virulence. However, as secondary invaders, the several varieties are of the greatest importance. In this sense fusiform bacilli and spirochaetes assume a rôle of great import in connection with a variety of processes. Their infectivity or power of invasion is usually very limited. But, as associated organisms in a given lesion, they develop rapidly and cause secondary changes of a character that often, indeed usually, overshadow the changes that were induced by the primary agent. These changes are normally, though not always, of a local character and include, for example, extensive necrosis, solution of tissue, production of characteristically foul-smelling volatile substances and, at times, distant metastases.

SUMMARY

Twenty specimens from chronic alveolar abscesses, obtained under controlled conditions, all revealed streptococci and fusiform bacilli. Sixteen revealed spirochaetes. Pus cells were commonly found.

From what is known of the relation of streptococci, fusiform bacilli, and spirochaetes, we would conclude that usually apical infections result from the combined activities of these three organisms. No doubt a variety of predisposing factors underlies the infectious process in alveolar abscesses.

REFERENCES TO LITERATURE

(1) Collins and Lyme 1919 *Journal of the National Dental Association*, vi, p. 370.
(2) Coronim and Preizel 1920 *Frankfurter Zeitschrift für Pathologie*, xxiii, p. 191.
(3) Davis and Pilot 1922 *Journal of the American Medical Association*, lxxix, p. 944.
(4) Gilmer 1914 *Dental Review*, xxviii, p. 427.
(5) Gilmer and Moody 1914 *Journal of the American Medical Association*, lxiii, p. 2023.
(6) Hartzell and Henrici 1913–15 *Journal of the National Dental Association*, i, p. 48; ii, p. 122; iii, p. 333.
(7) Hartzell and Henrici 1916 *Journal of the National Dental Association*, iv, p. 482.
(8) Pilot and Davis 1918 *Journal of Infectious Diseases*, xxiii, p. 562.

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Milo Hellman, D.D.S., Editor, 40 East 41st St., New York City

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RADIOGRAPHY IN EARLY DENTAL DISEASE[1]

JOSEPH A. POLLIA, M.D.

Los Angeles, California

This is the largest and most distinguished audience it has ever been my privilege to address. New York City has given me the highest appreciation for my meager efforts that I have as yet received. To appear before the First District Dental Society of New York is a goal to which all aspire and few attain. I fully realize the greatness of this honor accorded me and, in keeping with this memorable occasion, I wish to present what I consider my best radiographic contribution. It is my sincere wish that in it you will find something useful, something which can be taken home and used in practice.

The effect of diseased teeth on health has been the stimulus which led to the present state of development in dental or, as I like to call it, alveolar radiography. The medical profession, in its desire to explore this idea to the utmost, thus placed a premium on the detection of oral and alveolar infection. Consequently, dental radiography has been looked upon as the privileged specialty of oral surgery. This is a mistake, because radiography really is the greatest diagnostic aid to every branch of dentistry. Until it means to all departments what it means to oral surgery, the full value of its information, both as to scope and application cannot be obtained. At this moment let me make the point, that the detection of oral and alveolar infection is the least to be considered of the important radiographic advantages. Valuable as this may be, it becomes secondary to the detection of those signs that indicate changes which, if not arrested, will lead to infection. This is the topic of the evening.

You may think that I am going to talk on preventive dentistry. No, I am not. Preventive dentistry is a creditable step forward but I cannot understand why it is almost exclusively limited to children.

[1] Read at a meeting of the First District Dental Society of the State of New York at the New York Academy of Medicine, April 21, 1922.

Only when we consider its application to you and me, children who have grown up, can we call it a universal step forward; and it is here that radiography can be made to play its most important part.

Preventive dentistry seeks to prevent the development of oral disease. This cannot always be done, because the factors which produce disease are not always known. Even when they are known, disease cannot always be prevented because the factors may not be within control. To be practical then, when the incidence of disease cannot be forestalled, we must prevent the extension of the disease. This must be done at a time when the minimum amount of destructive change has taken place, so that effective therapeutic measures may be instituted at the earliest possible moment.

Radiography can be of utmost value in this phase of dental practice in the following ways:

1. It can locate disease processes which by their position are hidden from the most careful clinical examination, and go unnoticed until a sufficient amount of tissue is involved to produce symptoms.

2. Only the radiograph can reveal the true extent of bone involvement. Not infrequently a mouth having a favorable clinical appearance has a surprising amount of diseased bone tissue.

3. The recognition of these earlier signs of disease enables the general practitioner to prevent the extension of the lesion before it has progressed so far that it requires special skill. This places the general practitioner in the position of a bulwark protecting the masses from the advanced type of dental diseases, the treatment of which, requiring the specialist, is usually beyond their means.

4. The specialist finds much information of prognostic importance, which, combined with the clinical examination and considered with judgment and experience, will avoid disappointments in the result achieved, both for himself and the patient, by indicating the tissue involvement. This will avoid unwarranted hopes in the operator and therefore unjustifiable expectations in the person treated.

5. The radiograph is the only indicator available which shows the actual effect of dental therapeutics, whether they are periodontal, prosthetic, operative, orthodontic or surgical. This statement may be considered by some as unwarranted. When it is borne in mind that it is the condition of the bone and not the clinical appearance that truly

determines success or failure of a treatment, the reason for this contention is obvious.

Perhaps you are surprised that a radiograph may contain so much, and some may be even incredulous, because many of the radiographs that are produced give no more than a general survey. Here I want to say that the details of radiographic information mentioned above are by no means all that there are; and that it is only a question of obtaining radiographs that have certain requisites, and then of detecting the variations of minor degree as accurately as the grosser and more evident lesions.

Radiographs have value, in proportion as they conform to the following requisites:

1. Freedom from technical artefacts.
2. Minimum distortion.
3. Faithful reproduction of cancellated spaces and bone trabeculae.

Not less than two views of every tooth and three views of the upper molars, all the edentulous areas, bridged or not, the maxillary tuberosity and retro-molar spaces, should compose an oral radiographic examination. This requires from sixteen to twenty films.

Many variations in radiographic density are caused, and much of the fine detail needed for the demonstration in the film of these points under discussion is lost, by the failure to recognize that radiography is one of the most exacting branches of photography. It is the disregard of fundamental photographic laws and their application to radiography that is responsible for some of the common defects mentioned above as "technical artefacts." The most frequent contributors to this group are:

1. Operating-room factors
    a. Careless handling of the film before and after exposure, thus causing fogging, the most universal of all dental radiographic defects.
    b. Unscientific and empirical time of exposure.
    c. Too great penetration or high spark gap.
    d. Neglect to maintain a constant target to film distance.
2. Dark-room factors
    a. Improperly equipped darkrooms, which fog the films through light leaks and make proper washing, and drying

impossible; also, the idea that this part of the radiographic cycle is the least important.

b. Solutions that are,
   (1) Too old.
   (2) Too warm in summer and too cold in winter.
   (3) Carelessly mixed; or in which hypo gets into the developer, and an excessive amount of developer gets into the hypo.

c. Lack of definite technique in developing.

d. Disregard of time method in developing, which is the most constant and certain for the average practitioner, and the choice of the visual method, which requires exceptional skill and experience in developing.

As for "minimum distortion," it must be remembered that there are two types of distortion, that of length, recognized as elongation or foreshortening; and that of breadth. The first of these is a well known offender of radiographic esthetics, but not very much attention is paid to the latter. As a matter of fact, in the mesio-distal distortion, or vice versa, the relation of the periodontium is altered and, as we shall see, it really becomes a more important defect than that of length, in the consideration of early findings of dental disease. An important step toward the perfection of the essentials of technique will have been made when this type of radiographic deformity is eliminated.

With reference to "faithful reproduction of the cancellated spaces and bone trabeculae," it must not be lost sight of that a great amount of misunderstanding may be traced, in the interpretation of the film, to the lack of true bone definition, which is the correct picture of the characteristics of that tissue. In order to reduce this distortion to a minimum and to get the cancellated structure in the film as accurately as possible, it is necessary to apply certain geometric principles of parallelism, which cannot be discussed at length here but which must be incorporated in every good radiograph.

The usual cry at this particular juncture is, that we cannot get what speakers on radiographic subjects always demand. It is to be remembered that the radiographers give only as required. The desire for better radiography must come from the dentist, who must

inform the radiographer what he wants, and in order to demand good radiography, the dentist must know what constitutes it. The patient has to be considered also. To a majority of practitioners the requirements of two views of every tooth, three views of some teeth, the edentulous spaces and the retromolar fossae, will appear unnecessary in most cases, and it is very difficult to convince a patient who comes in with a minor tooth trouble, that it is to his interest that such an elaborate examination is requested.

Full-mouth radiographic examinations should be demanded of every case. A dentist seeks to maintain the highest integrity possible in a given mouth. Therefore he must first determine the index of oral health, and this cannot be done by picking out the dark, crowned, discolored or deeply involved carious teeth, which by their very appearance present grave problems.

The dentist must regard his responsibility as guardian of his patients' oral health as so important that he should leave no stone unturned in his effort to attain that end. For example; a man has a headache, a chronic one, which has been troubling him for a long time. He may be treated by two types of physicians, the first, who gives him ten grains of aspirin and sends him home, or the second, who subjects him to an extensive examination. Which of these men is doing the most good? The one who gives relief, or the other, who by his careful investigation reveals the commencement of a serious disorder that if unchecked would prove fatal. Which dentist fulfills his mission better, the one who has a radiograph taken of a tooth extensively decayed, to see if the apical involvement is or is not sufficient to indicate extraction, or the one who obtains a routine radiographic examination of all the teeth, and thus locates a caries in the earlier and more tractable stages, before extraction need be considered at all?

With the best radiographic work obtainable, the dentist may still overlook a goodly part of the available information,

1. By not having proper illumination by which to study the radiographs.

2. By the lack of a systematic routine in reading films, whereby all changes seen may be noted and registered.

Window-pane illumination cannot be too strongly condemned. Some radiographers claim that the north light is the best. But it really

makes no difference whether the light comes from the north, south, east or west, as it is not the direction of the source but the quantity that is at fault. Daylight is the strongest light available, and therefore necessitates a darker radiograph than is justifiable, which cannot be obtained without over-development or over-exposure and to which must be sacrificed fine detail that cannot be spared in early disease detection. Then, the observer cannot give ample time to the careful study of each film, when his arm is getting tired holding the set up to the window. Lastly, the human retina, like any other nerve tissue, gets accustomed to one intensity of the impressing agent, light in this instance, and attains a quicker appreciation of the slighter variations in density results if the degree of reading illumination is constant.

Before passing to the systematic routine in the reading of the films, let us review the standards by which we are to judge what we see. Every practitioner who reads radiographs of the alveolar process should possess absolute knowledge of what constitutes the normal radiographic characteristics of the alveolar process and of the tooth and periodontium. It is indeed to be regretted that many exponents of radiographic interpretation are better able to describe pathological characteristics than the normal. However, the final judgment on any radiographic variations must rest on how that differs from the normal, and in what respects.

The predominant feature in a radiograph of the alveolar process is the cancellous tissue. The normal cancellous tissue looks, in the radiograph, exactly as it does when a photograph is taken of the bony structure of the maxillary or mandibular process with the outer cortical plate removed. The best way to become acquainted with this picture is to take a maxilla or mandible, remove the outer plate and study its essentials. It will be found that the normal bone is made up of strands of tissue, which enclose irregularly-shaped spaces. This gives the first of the characteristics of the normal process, the irregular cancellated spaces. This is not altered by age provided the individual is in a good state of health. Age alters the chemistry of the alveolar process, not its morphology.

Calcium salts are another feature of bone tissue. Therefore in a healthy process the quantity is balanced. In other words, there is not any localized indication of increase or decrease in the calcium salt

content. When such a deviation occurs then there is a daub of black indicating decrease, or daub of white showing increase in the calcium salt content. Either of these states would spoil the beautiful dark and light shading characteristic of the normal bone tissue, and concommitantly would alter the definite, clean-cut shadow of the trabeculae. Summing up the characteristics of the normal process, there are the following:

1. Irregular, clean-cut and definite cancellated spaces.
2. Harmonious blending of the lights and darks.

In a pathological variation *both* of these characteristics are altered or lost.

The most important part of the radiographic anatomy is that depicting the relationship of the tooth to the peridental membrane, the lamina dura or peridental lamella, and the alveolar process. Within the circumference of these three tissues lies a greater part of the early disease expressions. In the radiographic picture of a normal tooth there is to be seen a fine black line, a fine, even, white line and the relation of the white line to the tooth. The intimacy of the tooth to these structures, and to the peridental lamella, together with the effect of the peridental membrane activities to the tooth, forms an interesting source of very fascinating information.

In the radiographic picture the peridental membrane is revealed as a fine, even, black line of less than one millimeter in thickness. The uniformity of the radiographic appearance of this structure is characteristic of its healthy state. The peridental lamella is also a fine, even, white line which fits the tooth like a glove. The evenness of the peridental membrane, and the glove-like fit of the peridental lamella are the two normal lines from which we may sight the variations indicating the pathological. In these two are found the majority of the early indications of dento-alveolar disease. A third normal line is the smooth contour of the tooth and its roots.

Briefly then, we are going to look in the radiograph for:

1. A fine, even, black line, the reproduction of the peridental membrane, which is less than 1 mm. wide.
2. The fine, even, white line, which fits the tooth like a glove, the peridental lamella.
3. No aberrations in the tooth contour.

Whenever an irritant, be it traumatic, chemical, pressure or bacterial in character, affects a tissue, the irritant produces a reaction therein called inflammation. Inflammation is the defensive and regenerative reaction of living tissue against injury. It is to be understood that each of the above irritants is capable of producing identical changes of this character, and it is only by the effects that the differentiation between them is possible. It is unfortunate that inflammation has been so frequently synonymous with infection, because it confuses the etiological factor by applying the same treatment for all inflammatory conditions even when the cause is not bacterial.

Dental disturbances of inflammatory nature reach the alveolar process in two ways:

1. Intra-dental, through the pulp or root canals.
2. Extra-dental, when the irritant originates outside the tooth but through the medium of the tooth affects the surrounding bone tissue.

In either route, the peridental membrane shows the first changes because it is the tissue closest to the tooth on the one hand and to the bone on the other, the difference being shown in the location of the peridental membrane changes. In the intra-dental, naturally, the changes are seen at the point where the irritating agent escapes from the root canal, at the foramen. This need not always be at the apex, but may be at either the mesial or distal aspects. Therefore it will be noted that an intra-dental irritant produces a localized area of change in the peridental membrane in the first stages. When the entire tooth acts as the agent through which the irritant operates, then the changes are seen in the entire peridental membrane.

What are the changes? The peridental membrane is a fibrous tissue with specialized functions and because of this has a generous blood supply, which makes it have greater defensive powers against irritants. So that the majority of radiographically-demonstrable, peridental lesions are necessarily of chronic inflammatory character. Chronic inflammations in a fibrous tissue cause its proliferation. Therefore thickening of the peridental membrane at any point as seen in the radiograph indicates chronic inflammation present at the point of irritation. As was said before, the point of irritation may be localized in the case of an intra-dental irritant, or generalized in the

extra-dental. Now it can be concluded that any thickening of the fine, even, black line of one millimeter or over must be regarded as pathological until proved to the contrary.

The peridental lamella or lamina dura is affected by the lesions of the peridental membrane in one of two ways, or both:

1. The "tailored" fit of the lamella is altered by being pushed outward. This change is due to the pressure of the proliferating peridental membrane.

2. The lamella itself is changed either through its destruction or pathological proliferation.

Imbedded in the peridental membrane are found cementoblasts and cementoclasts on the tooth side and osteoblasts and osteoclasts on the lamella side. It is obvious then that any disturbance in the peridental membrane should produce changes in the contour of the tooth, as the absorption or proliferation of cementum are shown radiographically by erosions and destruction and bulgings. It must be remembered that the cementum is a very thin structure, therefore it is more accurate to state that in the case of absorption a certain amount of root structure is also involved.

Up to this point, it is assumed that radiographs are at hand having minimum distortion of the teeth and reproducing faithfully the cancellated spaces and bone trabeculae; that are free from technical artefacts; which depict two views of every tooth, three views of the upper molars, the maxillary tuberosity and retro molar spaces; and that the radiographer has the working knowledge of the radiographic anatomy of the bone tissue, the tooth and the periodontum which have just been discussed. The other factor that is necessary, besides proper, stable illumination, is, a systematic routine in the examination of the films, whereby all variations in density can be observed and recorded.

There are, no doubt, many ingenious ways of reaching this aim, but personally I have found the following method the most practical. Briefly, it consists of subdividing each tooth into its anatomical parts and examining each one of them separately. It is of interest to note that in this method the alveolar process is looked at last, because, in fact, the alveolar state is merely a reflection of conditions existing in the other parts. Quite often the absence of alveolar bone changes

causes the earlier or beginning lesions to be overlooked, thus defeating any preventive measures that might be instituted.

For the purpose of radiographic examination I have found it convenient to divide the tooth structures as follows:

1. Crown.
2. Cervical portion of tooth.
3. Pulp chamber and canal.
4. Peridental membrane, for variations in thickness.
5. Contour of tooth root.
6. Peridental lamella, for thicknesses and bulgings.
7. Alveolar process.

It is always advisable to mark the film at any point where a variation in density is seen. This is best done with a china-marking pencil. At clinical examination these marked places should be investigated and this will give a better opportunity for determining the character and extent of the variation. I make it a rule to consider every radiographic variation as pathological until proved otherwise.

From the above routine it will be noted that the best time to study the radiographs of a given case is before the patient comes in for the chair examination. The attempt to study the radiographs and look over the mouth at the same time usually results in one or the other's lacking in thoroughness, quite frequently the first.

Then we proceed to examine the

1. Crown:
   - Contour of the occlusal surface.
   - Irregularities of enamel or tooth development.
   - Radiolucent spots at margins of restorations or contact points.
   - Deposits of calculus.
   - Defects in tooth surface restorations.
2. Cervical portions:
   - Erosion.
   - Subgingival caries.
   - Thickened cervical peridental membrane.
   - Radiolucence or destruction of the interproximal bone septa, or alveolar crests.
   - Excessive therapeutic instrumentation.
   - Relation of gingival tissue.
   - Deposits of calculi.

3. Pulp chamber and root canal:
   Pulp concretions.
   Diffuse clouding.
   Irregularity in contour of canal.
   For recession of the pulp.
4. Peridental membrane:
   Thickenings which are
      (a) Generalized, when irritants are of extradental origin.
      (b) Localized, when intradental in origin; found
         (1) Apical.
         (2) Mesio-marginal.
         (3) Disto-marginal.
5. Contour of tooth root:
   Increase of contour (excementosis) or blastic activity.
   Decrease of contour from clastic activity; which is
      (a) Moth-eaten.
      (b) Completely absorbed.
6. Peridental lamella:
   Sagging of lamella from the pressure exerted by the thickening of peridental membrane beneath.
   Destruction of lamella from clastic activity.
   Hypertrophy from blastic activity.
7. Alveolar process:
   Radiolucence or radiopacity, or combinations of both.
      (a) Generalized variations in extradental agencies.
      (b) Localized variations in intradental agencies.

MEANING OF RADIOGRAPHIC VARIATIONS

The crowns of the centrals, laterals and cuspids are more satisfactorily depicted than those of the bicuspids and molars. With refinement of technique the latter two will improve. The crown exhibits some valuable signs, I believe, which point to the probable occlusal habit of the patient. May I suggest to you some new terms which I have found useful in describing the most likely radiographic etiology? I call all conditions of error of occlusion, 'malocclusion.' Malocclusion may be:

1. Hypo-occlusion; where the impact is less than normal.
2. Traumatic occlusion; where the stress creates pathological conditions along its line of direction. Traumatic occlusion may be:
   (a) Hyper-occlusion; where the stress is greater than normal.
   (b) Excentric occlusion; where the amount of stress is normal but is directed along an improper axis.

I have been studying this last form and it seems that it also creates a very typical radiographic picture. However, not enough cases have been examined to justify definite conclusions.

Taking up inspection of the occlusal surface, which appears as a line in the picture, there will be seen:

1. The fairly straight line which is incident to normal wear.
2. The convex curve or presence of developmental tubercles indicative of hypo-occlusion in the first, and disuse in the second, provided the patient is old enough.
3. Serrated, abraded or chipped surfaces, which show both varieties of traumatic occlusion.

I wish to repeat that the radiographs are valuable as signs which point to the probable occlusal habit, and that in order to determine the degree of abnormality and the exact character, one must have a set of well made and accurately mounted casts.

Irregularity of enamel development is obvious. Its presence should call to mind hereditary syphilis and the severe exanthemata, or diseases of children, and their possible sequelae or complications. The occurrence of these conditions at the time when the permanent teeth are developing may alter their ultimate morphology. Furthermore the presence of these enamel defects should lead to inquiries as to the present state of the patient's health, as it is well known that measles, scarlet fever, smallpox, acute rheumatic fever and severe diptheria very often leave damaged kidneys and hearts. This information can readily be appreciated in this day of novocaine, suprarenin, nitrous oxide, oxygen and general anaesthesia.

Early caries is to be sought for at:

1. Margins of tooth surface restorations.
2. Contact points.

I have no hesitancy in stating that caries can be radiographically

seen much earlier than it can be clinically demonstrated. The reason for this is clear, when it is considered that caries, regardless of its probable etiology, is essentially a process of decalcification, and therefore any diminution of the calcium salt content is seen in the picture as a radiolucent spot contrasting with the dense radiopacity of the normal enamel. This affected area, so readily discernible radiographically, need not necessarily possess sufficient decalcification to to pit the enamel or to permit the explorer to penetrate into it. Deposits of calculus are seen at the interproximal spaces and also as a radiopaque shadow of a varying degree of intensity, which runs across the tooth mesio-distally at the junction of the middle and lower thirds. The radiograph is of great value in indicating the accuracy of fit of the tooth surface restorations, and the thoroughness of the extirpation of the caries. It is surprising what an impartial and silent critic a radiographic film can be on both of these points.

At the cervical portion, or neck of the tooth, are found radiolucent spots which may be due to erosion or subgingival caries. Differentiation between these lesions is not always possible radiographically, although a simple matter clinically.

Thickening of the peridental membrane at the neck of the tooth, represented by an increase in size of the fine black line is the forerunner of the pyorrheic pocket and may occur without gingival changes or in conjunction with them. In both instances there is associated with the thickening, a radiolucence or, if further advanced, a destruction of the interproximal bone septa. It must be remembered that normal bone septa have two forms.

1. Spear point in the central, lateral and cuspid regions.
2. Table form in the bicuspids and molar areas.

Incipient periodontoclasia is manifested by:

1. Thickening of cervical peridental membrane, which indicates proliferative chronic inflammation.

2. Radiolucence, or destruction of the interproximal bone septa. This shows that the inflammatory activity has spread to the bone tissue. The degree of these changes may be very slight, but when present should direct close attention to the possible presence of malocclusion. My personal experience has been that whenever these lesions existed and there was no direct local cause such as ill fitting crowns, calculi, etc., traumatic occlusion usually was found.

The consequences of excessive therapeutic instrumentation are self-explanatory.

In a well taken and well developed radiograph, it is possible to delineate accurately the gingival tissue in its relation to the bone and the tooth. Some observers claim that it is not possible to reproduce soft tissue inflammatory changes with the x-rays, and therefore deny that the early changes of periodontoclasia can be seen in the radiograph. To this I will say, that with proper technique radiographs can be produced which will show very clearly the soft tissue lesion; and furthermore, the early syndrome of periodontoclasia expresses itself in the peridental membrane and bone tissue as well as in the gingival, and in about fifteen per cent of cases the gum may appear perfectly normal while the periodontium presents marked radiographic variations. Therefore, the presence of the increased gingival shadow aids the diagnosis by adding a little more evidence.

The pulp chamber and root canal very often contain areas of calcareous degeneration of the pulp. This type of lesion is the result of an inflammatory activity. Any condition which excites a severe pulpitis may produce this abnormality in the pulp tissue, as well as the familiar strangulation and death of the pulp. Calcareous degenerations exist in three forms:

1. Localized concretions, or pulpstones.
2. Generalized concretions, which may vary from diffuse clouding to the entire obliteration, old age excepted.
3. Degeneration along the walls of the pulp chamber, and canal.

All three forms may be found in a single tooth. Among the principle causes of this lesion may be mentioned severe febrile diseases which produce the diffuse clouding in the pulps of all the teeth, traumatic occlusion, and any therapeutic effort which produces severe prolonged inflammatory reaction that directly involves the pulp through the dentine, such as in cavity preparation. or indirectly, as in some forms of treatment of periodontoclasia. Occasionally pulpstones are seen in teeth that have not this history, and these can be classified as idiopathic. Therefore, it is seen that this lesion indicates the presence of either an active or a subsided irritation. This knowledge may be useful in directing the best therapeutic method in a given case.

Whenever a tooth acts as a channel through which an irritant may reach the alveolar process, its related tissues are affected in their entirety. Therefore a generalized pericemental proliferation indicates an abnormal outside influence, the most common being traumatic occlusion. However, when the injurious element is located within the pulp then the peridental membrane can only be reached at a point of exit, which is usually at the foramen. This produces the localized lesion. Localized thickening of the peridental membrane is the most important radiographic sign of beginning pulp disease. Speaking of pulp disease, it must be remembered that a pulp may be irreparably diseased or infected, and still give a positive vitality test. Therefore, a vital pulp must not be considered as normal because it responds to stimuli, as that indicates only that it is alive, and *not* its state of health.

According to the location of the foramina or points of exit these proliferations are found. It is interesting that the so-called chronic dento-alveolar abscess, or granuloma, is in reality a very marked thickening combined with inflammatory cells and could very well be designated as a pericementoma. At any rate, localized thickening of the peridental membrane always precedes the pericementoma and is the first radiographic sign that the disease is no longer confined to the pulp but is spreading outward. Intra-dental irritants are usually bacterial and rarely auto-proteolytic.

The peridental membrane undoubtedly exerts some controlling influence on the contour of the roots, since both types of cemental cells are found imbedded in it on the tooth side. Therefore it is not probable that inflammation of the membrane can exist without some concomitant activity of the cementoblasts or cementoclasts. The presence of excementosis indicates an irritant which excites the cementoblastic activity. This of course increases the size of the affected region. Excementosis occurs in many degrees. Unfortunately, only the large mushroom-like proliferations have been noticed. But if radiographs are examined carefully, it will be seen that small deposits of pathological cementum are quite frequently found. These, as in the case of calcareous pulp changes, indicate inflammatory activity and should call for investigation as to the type of irritant and if it be still present.

Whenever the irritant induces a clastic or destructive activity, the opposite condition is to be found. Not all of the absorbing or tooth-destroying activity is carried on by the cementoclasts, but undoubtedly some of the ferments liberated by the destroyed inflammatory tissue cells or bacteria aid in the disintegration. Two forms are seen radiographically:

1. Where there is a pitting or loss of the smooth tooth contour.
2. Where there is complete absorption of the involved area, producing a shortening of the root or a deep depression.

Clinically in the first, the extracted tooth is familiarly said to feel like a "cat's tongue."

The peridental lamella is a fine layer of compact bone which lines the alveolar socket. It has numerous holes to contain the attaching fibres of the peridental membrane and because of this was called, by Noyes, the cribriform plate. It is the bony barrier between the tooth and peridental membrane and the cancellous bone of the alveolar process. It hugs the membrane and therefore any abnormality that it may possess will be reflected in the lamella. Pathological influences in the peridental membrane always destroy the accurate "tailored fit" of the lamella by the proliferation of the membrane, pushing it away from the tooth. In other words, whenever a sagging of the lamella occurs it is due to a chronic inflammation of the peridental membrane lying beneath it. In addition to this the lamella may be:

1. Rarefied or destroyed by pressure, osteoclastic or proteolytic influences.
2. Hypertrophied through irritants which tend to morbid regeneration.

The alveolar process shows two types of changes:

1. Rarefying, or atrophic,[2] producing the radiolucent variation.
2. Condensing or hyperplastic, producing the radiopaque variation.

Either or both of these lesions may be produced by the same irritant, and never occur without also damaging the irregular, definite, cancellated spaces. Whenever an atrophic or hyperplastic bone change occurs in the bone tissue all around the tooth, then the inflammatory influence lies without the tooth, but where located mesio- or disto-marginally or at the apex, it will often be found in the pulp or in the root canals.

[2] Pollia: *Journal of the National Dental Association*, 1922.

SOME RADIOGRAPHIC MANIFESTATIONS OF EARLY DENTAL DISEASE

1. In early caries:
   Small radiolucent areas, at contact points, margins of restorations and at the cemento enamel junction. It must not be forgotten that these may be radiographically demonstrable before they can be clinically verified.
2. Early periodontoclasia:
   (a) Cervical pericementitis.
   (b) Radiolucence, or varying degree of destruction of either the interproximal septa or alveolar crests.
   (c) Increased radiopacity of gingival shadow.
3. Traumatic occlusion, radiographically indicated by the following:
   (a) Serrated, chipped or concave occlusal line.
   (b) Radiolucence or destruction of septa or crests.
   (c) Generalized pericemental thickening (pericementitis).
   (d) Calcareous pulp degeneration.
   (e) Slight or moderate excementosis.
   (f) Separation and hyperplasia of the peridental lamella.
   (g) In molar region, generalized radiopacity of alveolar bone tissue (hyperplasia). Around all other teeth, generalized radiolucence (atrophy).
4. Incipient or moderately advanced pulp disease:
   (a) Localized pericemental proliferation (point of exit).
   (b) Separation of the peridental lamella at that point.
   (c) Destruction or hyperplasia of the lamella.
5. Radiolucence or radiopacity of edentulous regions resulting from persistent, or retained infection, or from the extension to the bone of gingival inflammations which are produced by faulty restorations.
6. Involvement at the bifurcation of molars:
   This is a very serious condition found when the disease has spread from the gum tissue and alveolar crest to this point. It is the opinion of the best periodontists that it presents at least a grave prognosis. I am positive that in the beginning, it may be seen radiographically at a period when the involvement is limited to the peridental membrane of

the bifurcation. It appears as an increase in the fine black line at the angle formed by the roots. Especially is this demonstrable in the lower molars. In the uppers the first radiographic sign, excepting in those cases where the bifurcation can be reproduced, is an increase of radiolucence of the bone tissue at that point. Involvement at the bifurcation is an extension of the cervical disease to that area. Therefore in the early case which has not produced changes in the bone, the elimination of the disease at the alveolar crest will in a measure, if not entirely, take care of the bifurcation.

7. Disease at the retromolar space:

Retromolar space is a small triangular space behind the last molar in the mandible. This is frequently the site of an infectious pocket which is overlooked and may, by destruction of the bone at that point, cause fracture of the jaw during extraction. Very often the infection persists after the most conscientious treatment and therefore this area should be very carefully examined clinically as well as radiographically.

FACSIMILE OF A REPORT OF THE FINDINGS IN AN ORAL RADIOGRAPHIC EXAMINATION FOLLOWING THE STANDARDS SET DOWN IN THIS ARTICLE

It will be noted that all radiographic changes are reported, no matter how minute or seemingly unimportant, but there are no therapeutic commands or suggestions.

Below please note the findings in the oral radiographic examination of Mr. X, taken September 27, 1923.

UPPER RIGHT:

Central: Slight cervical pericementitis with beginning destruction of the distal alveolar crest. Diffuse calcareous degeneration of the pulp. Moderate generalized thickening of the peridental membrane and lamella. Slight atrophic alveolar changes. Investigate occlusion.

Lateral: Slight abrasion of the incisal edge. Marked cervical pericementitis, beginning alveolar absorption, marked generalized pericementitis with proliferation of the lamella, atrophic alveolar changes. Investigate occlusion. Diffuse calcareous in the pulp.

Cuspid: Investigate for caries where marked.

Biscuspids: Show similar changes as the central and lateral, only of more marked degree.

First Molar: Large metallic restoration, marked absorption of alveolar crest, marked calcareous changes in the pulp, diseased or dead pulp, apical pericementitis of the disto-buccal root with small pericementoma of lingual apex, which shows some root apex absorption.

Second Molar: Pulp concretion, mesial absorption of crest, generalized pericementitis of the lingual root more marked at the apex with beginning absorption at apex.

Third Molar: Eruption incomplete.

UPPER LEFT:

Central: Slight absorption of alveolar crests with cervical pericementitis. Diffuse calcareous changes in pulp. Investigate occlusion.

Lateral: Investigate for caries where marked. Slight cervical pericementitis with mesial absorption of the alveolar crest. Diffuse pulp changes, apical pericementitis.

Cuspid: Investigate for caries where marked, other findings same as lateral.

Bicuspids: Serrated occlusal surfaces, absorption of alveolar crests, generalized pericementitis, hypertrophy peridental lamella and pulp recession. Investigate occlusion.

First Molar: Large metallic restoration, mesial contact lost. Investigate for caries where marked. Small pulp concretion.

Second Molar: Investigate for caries where marked.

Third Molar: Incomplete eruption. Cervical pericementitis.

LOWER ANTERIOR:

Abrasion of occlusal surfaces, absorption of interproximal bone crests, moderate cervical pericementitis, moderate proliferation of lamella more marked in the cuspids regions, generalized atrophic changes.

LOWER RIGHT:

First Bicuspid: Negative.

Second Bicuspid: Defects in restoration, slight cervical pericementitis, marked calcareous pulp changes. Excementosis of apical third, pericementoma associated with osteomyelitis.

First Molar: Distal metallic overhang, slight deposits of calculus. Distal absorption, incomplete root filling, absorption of both root apices with diffuse infective osteomyelitis.

Second Molar: Investigate for caries where marked. Cervical pericementitis, slight distal absorption.

LOWER LEFT:

First Bicuspid: Slight cervical pericementitis.

Second Bicuspid: Retake.

First Molar: Beginning cervical pericementitis.

Second Molar: Investigate for caries.

Third Molar: Investigate for retromolar and caries where marked.

SUMMARY

1. The detection of alveolar infection is the least of the great radiographic advantages.

2. The future of dento-alveolar radiography lies in its recognition as the principle diagnostic aid in all departments of dentistry.

3. The greatest value of radiography lies in its ability to point out early dental disease.

4. This value can be developed only when

(a) Full mouth radiographic examinations of all patients become a requisite in all dental offices; and

(b) When there is a careful and systematic reading of the radiograph.

5. The dentist must be alert in suspecting each radiographic variation known not to be of technical or anatomical origin, as having pathological significance until satisfactory evidence to the contrary is obtained.

6. The dentist must recognize the limitations of preventive dentistry as now conceived and the necessity for prevention or retardation of the extension of disease.

7. We must bear in mind that we do not truly have thirty-two teeth, but thirty-two varieties of one tooth each and therefore the loss of a tooth becomes a more serious problem than it is sometimes considered.

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Los Angeles, California

DISCUSSION

Paul R. Stillman, D.D.S. (New York City): It has been my pleasure to attend one of Dr. Pollia's course of lectures and I desire to take this opportunity to state my admiration for the man. Dr. Pollia combines those rare essentials of a good teacher, viz.: comprehensive knowledge of the principles of his subject, together with the faculty of being able to impart in a lucid and modest manner that which he knows. It is Dr. Pollia's ability to present an unfamiliar fact in a humble-minded manner and with simplicity, which arouses my admiration. His education and training may compel him to admit that he is a physician, but as for myself, I shall rate him as one of the foremost dental teachers of this period.

Those of us who are called upon to interpret from radiographs those changes which injurious agents produce in the tissues, should not forget that the record upon a film is not a photograph but is a shadow. We should keep in mind that most shadows are usually distorted in their outline forms. If our knowledge of the appearance of the human form was derived wholly from its shadow, it is evident that most of us would have a very incorrect idea of what the human form really was like. It is occasionally possible to reproduce the true dimensions of a tooth upon the film, but a very high percentage of all radiographs present distortions of dental outline form. Nevertheless, when one is walking along a sandy beach with his interesting shadow preceding him, there occurs no doubt, even with the exaggeration of the shadow, as to whom the shadow belongs. And when the angle of the sun and the incline of the beach are correctly comprehended, and these facts added to our positive knowledge of the actual outline of the figure, the shadow soon assumes the attributes of a silhouette portrait. It is just so with the radiograph. If we are actually to visualize what the radiograph records, it becomes necessary for us to see the recorded objective from an angle and plane similar to that from which the radiograph was taken.

Personally, I find it helpful to read all my radiographs in the presence of my patient. It is then possible to see the object as well as the objective and by carrying the record on the film to the object, a similar angle of perspective may be assumed. It is then possible with the aid of the faculty of imagination to penetrate with the mind's eye directly into the tissues just as does the x-ray itself. My own sense of humor makes me quick to perceive the absurdity of this proposition. At the same time we know that there are many truths which are just as absurd. As an instance I can cite the aviator—the flying man, or the Siamese twins who died the other day. These are absurdities. I ask you to take a film of the upper central incisors. These records are usually distorted, yet they are usually distortions of a similar kind. Require your eyes to record a mental picture of the radiograph. Now pose your eyes upon the object at an angle similar to that from which the film was exposed and look directly through the maxilla visualizing that which is on the film and not what the eyes record upon the surface of the object. This is a very simple experiment. The maxillary suture and the anterior palatine foramina will at once take on perspective as if seen through the stereoscope.

As Dr. Pollia has taught us, we should keep clearly in the fore our knowledge of the normal if we are to be able to detect the abnormal. The custom of radiographing only those areas which are obviously in a state of disease and omitting to film all those which were apparently in a state of

health, was a most careless practise. This has led us all into grave diagnostic errors of omission.

I approve Dr. Pollia's plan of taking twenty diagnostic films for each case, using identical technic in every case. The perspective in such a procedure becomes a principle and this obviates much opportunity for error in reading films.

I thank Dr. Pollia for the aid he has given me, and I congratulate my fellow members who have heard him tonight.

Herman E. S. Chayes, D.D.S. (New York City): The goodly number that was present at the beginning of the evening has simmered down to those who remain interested to the last. I must say, Mr. President, that I could not if I tried, express my appreciation in better words than those chosen by Dr. Stillman, who preceded me and I must thank Dr. Stillman for taking this task out of my hands, or rather my mouth. It was as beautiful a tribute to a man as I ever heard paid to any man at any meeting such as this.

I am sure we all feel we have been overlooking many important things in the reading of radiographs and we are thankful to Dr. Pollia for calling our attention to these findings. The examination of radiographs as outlined by him will make us infinitely more careful in the handling of living tissues than we were before.

I am to discuss Dr. Pollia's paper from the aspect of a so-called prosthetist. I do not know why that should be so, why they should give us different names. I like to consider myself a dentist; I hope I have earned that privilege. If this exposition tonight results in anything at all, it should result in making you infinitely more careful how you handle teeth in the investing tissues of the mouth. The manner in which some of us approach the human mouth would make one think the integrity of it could never be jeopordized. You have seen how delicate the differentiation is between the healthy and the unhealthy, between that which is inviolate and that which has been violated.

For many years and only last month as a climax to these many years, I have told you, perhaps not in the same words, but I have tried to show you fundamentally why it is we should not violate the human mouth by an appliance termed a fixed or removable type of bridge. The radiograms shown on the screen by Dr. Pollia tonight, showing the regeneration of bone under Chayes movable removable bridges, give justification to all the claims that I have made for this work and establish beyond the possibility of argument the correctness of the principles of restoration which I have attempted to promulgate. The folly of fixed bridgework and clasp work is easily demonstrated, if you allow yourself to think. Let me try

graphically to describe to you the difference between a fixed appliance, which in my mind violates human mouth integrity, and the results of a correct appliance as demonstrated by the radiograph to-night. Take a man who lives at 42d St. and Broadway in the City of New York, for instance and transfer him suddenly to some place, let us say, outside of the United States—Hoboken. Naturally that man who was accustomed to live in New York, who had his friends and his habits definitely established and was mentally habituated to them, transferred to Hoboken, finds himself at a loss indeed. Suppose you transferred him at six o'clock in the evening, in the subway train, packed to the doors. That man would be mighty uncomfortable and yet he could turn in any direction he wished, even though he were uncomfortable.

Suppose, however, you took that man bodily and instead of transferring him in the subway, you rigidly chained him to five or six other men who likewise were going to be transferred to Hoboken, so he could move neither to the right nor the left, neither to the front nor the rear, without pulling every other man with him. Do you think that man could enjoy that freedom of motion that he was entitled to? No, he could not.

And it is the same with the tooth as it is with the man. Now do you see it? This intermittent stimulation which comes from the independent tooth motion which is accomplished every time that tooth is brought into normal use, which motion is in a definite direction and to a definite degree, is an absolute essential to the normal well-being of that human masticatory apparatus, and especially that particular tooth and the investing tissue.

When you extract teeth from the human mouth and insert therein a denture which is to take the place of the teeth extracted, you must by a saddle supply the means for the re-stimulation necessary for that area of the tissue a stimulation which was there when those teeth were in their normal position. It would be interesting to see to what extent the so-called clasp dentures bring about that condition, when we gather together the radiographs of those who have worn clasp dentures for some time. I have repeatedly told you that a clasp upon a tooth acts as a destructive agent, not only of that tooth, but of the nerves and tissues. I have told you, and I hope Dr. Pollia will speak of it in his closing remarks, that it comes from the ectodermic layer of the blastoderm and that the constant friction against the enamel of a tooth by means of a clasp, with the saliva as the electrolyte, cannot but ultimately destroy the tooth and also the investing tissues. Where does this constant friction manifest itself? Where would it manifest itself, if you were in trouble in a strange city? You would

go to your cousin, or your sister, or your father, or anyone of your family. It does the same in the mouth—it manifests itself in a central irritation in the cerebro-spinal area, and here are many cases of melancholia, introspection and such manifestations as show themselves in nervous irritation.

I feel this society owes Dr. Pollia a tremendous debt—I feel I do myself. He has made concrete vague ideas for me and for sixty-five others who have taken his instruction. He is fortunate indeed to have been able to accomplish so much at his age. It is not given to all of us to reach a mature understanding of a subject at his years.

To my mind, his paper tonight is a victory for me, but I pray I may be humble in my victory. None of these saddle pictures are my work, but of students who have taken this work, some under me and some under others, but it has opened my eyes to the fact that we have not the right to restrict the use of these appliances to such only as have taken a course of instruction. There are minds, I realize now, that are bright enough to work out these problems of restoration in their daily practice and I shall make it possible for any practicing dentist to avail himself of them. I want to thank Dr. Pollia for his great gift to dentistry.

Dr. Pollia (*in conclusion*): Mr. President, and fellow members, I feel very grateful for the kind things you have said about me.

Doctor Stillman, I want to thank you for your kindness to me, this evening. It is my opinion that with proper technique distortion can be reduced to a minimum. Distortion has a great deal to do with the lack of definite radiographic information, but if we understand, as Doctor Stillman says, the planes of projection, the contour of the projected tooth plane upon the flat film plane, we can get at least an approximate idea of what we are looking for. Let us do the best we can with our present standard and devote further effort in getting truer radiographic reproductions.

Doctor Chayes expresses a beautiful thought in his statement regarding the respect of human tissue. That is the noblest deed in the practice of the healing art. Physicians and dentists are members of the greatest professions, because they handle the noblest of all things, human tissues. However, we have not been so careful. Wherever we have failed, the radiograph will detect it. There is one point which physicians in their relation to dentistry have not realized and that is, that the most difficult problem of dental practice is the proper replacement of a lost masticating surface. When physicians speak of removing teeth because they are more accessible we have not the proper conception of this difficulty, to say nothing of expense and the additional burden which the supporting tissues have to as-

sume in order to prevent the artificial substitute from becoming a menace instead of an aid.

In closing, I wish to thank you for your kind attention and I sincerely hope that some of the things that were said this evening may prove of value.

PLATE 1

FIG. 1. Normal alveolar bone tissue in the maxilla. The cancellated structure is definite, and made up of irregularly shaped spaces. There is an atrophic degeneration of slight degree of the bone tissue between the lateral and cuspid, due to the pathological loss of contact between the two teeth; which shows how beginning pathological conditions are plainly visible radiographically.

FIG. 2. Normal alveolar bone tissue in the mandible between second bicuspid and first molar. The cancellations have a more definite appearance because the angle of penetration of the ray is more direct. The apex of the pyramid of bone occupying the space formed by the first and second molars, shows hyperplasia (hypertrophy[3]) due to traumatic occlusion.

FIG. 3. Normal peridental lamella and peridental membrane. Both structures have their characteristic evenness. The lamella has the "tailor-made" fit and does not vary in thickness.

FIG. 4. Peridental membrane and peridental lamella relationship. (Radiograph by Doctor Ottolengui.) The lamella is thicker than normal. This picture shows in a slightly exaggerated manner the characteristics described above, also the normal tooth contour which is a series of fine curves tangent to one another.

FIG. 5. Diseased bone in the maxilla. Here there is seen the homogeneous or "muddy" appearance, with loss of definite cancellations and increased radiolucence, varying from the slight to complete destruction seen at the apex of the first bicuspid.

FIG. 6. Pathological mandibular alveolar process. The same homogeneous aspect is seen, although this is the hyperplastic type of disease. Arrow points to the presence of a retromolar disease. Bone tissue which gives the radiographic expression of loss of definite irregular cancellations plus increased radiolucence and increased radiopacity, is the result of disease-producing influences.

FIG. 7. Second bicuspid has marked proliferation of the peridental membrane (pericementoma, "dento alveolar abscess" or "granuloma"), destruction of the peridental lamella. First bicuspid has thickening of peridental membrane at the apex, or pericementitis, the forerunner of the pericementoma. First molar's lingual root shows the apical pericementitis more advanced.

FIG. 8. The peridental membrane thickens at the point of irritation and the peridental lamella is pushed out of the way destroying the "tailored" fit.

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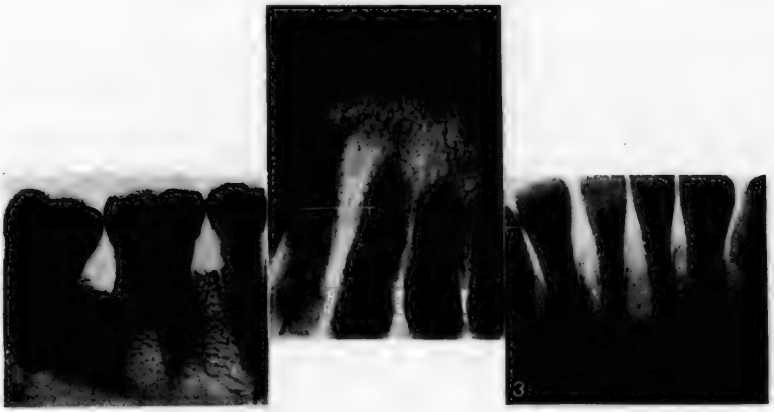
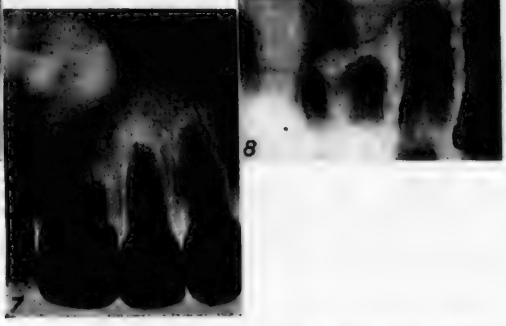
[3] See Pollia: The Alveolar Radiogram. What It Tells. *Journal of the American Dental Association*, January, 1922.





(Pollia: Radiography in Early Dental Disease)

PLATE 2

Examples of cryptic and early caries

FIG. 9. Arrow points to the subgingival caries on mesial aspect of cuspid. Slight area of decalcification is also seen on the distal aspect. First bicuspid shows a very frequent site of hidden and early caries at the margin of restorations.

FIG. 10. Caries more advanced in the first molar.

FIG. 11. Subgingival caries.

FIG. 12. Small areas of caries at the margin of restoration in mesial of first bicuspid. Second bicuspid shows this type of caries; more advanced on the distal aspect of second bicuspid.

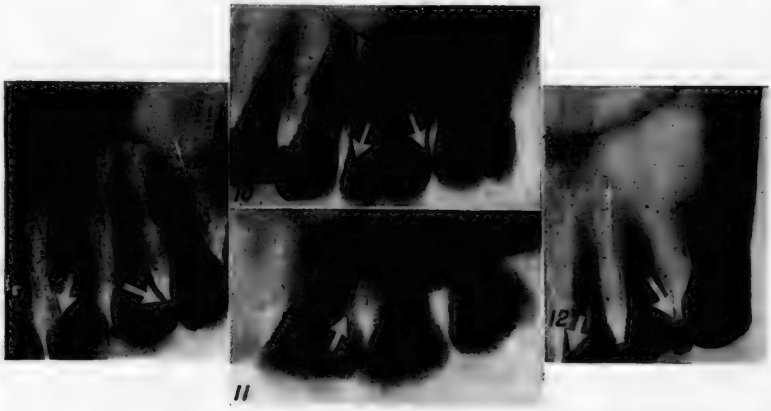
PLATE 3

FIG. 13.
FIG. 14. } Disease at the retro-molar space.
FIG. 15.

FIG. 16. Beginning inflammation at the bifurcation indicated by thickening of the peridental membrane of that region. In this stage the condition is usually due to the extension of the disease around the cervical region, and can be arrested by proper therapeutic measures at the pericervical area.

FIG. 17. Bifurcation disease further advanced.

FIG. 18. Bifurcation disease demonstrated in an upper first molar



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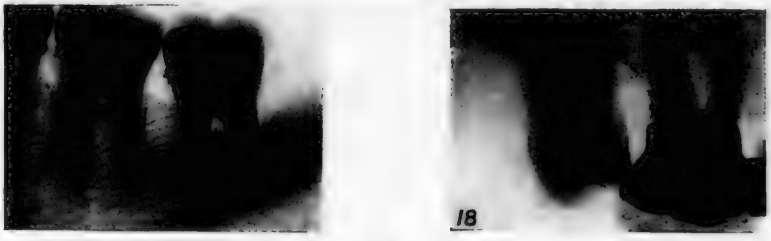

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(Pollia: Radiography in Early Dental Disease)

PLATE 4

FIG. 19. How pathological influences change the contour of the tooth. Second bicuspid has a large pericementoma. Associated with it is a destruction or clastic activity of the involved root end. First molar is also diseased but here the morbid regenerative or blastic influences are at work, producing cemental hyperplasia or excementosis.

FIG. 20. Effects of an overhanging filling. This is a very pronounced condition. Minor degrees of this type of defective restoration are frequently seen radiographically, the sight being more sensitive than the touch.

FIG. 21. The development of the periclasia pocket. Bone destruction follows proliferation of the peridental membrane. The area that was occupied by the bone fills in with an inflammatory type of connective tissue, which defeats any attempts at regeneration unless removed, because it acts as a limiting membrane.

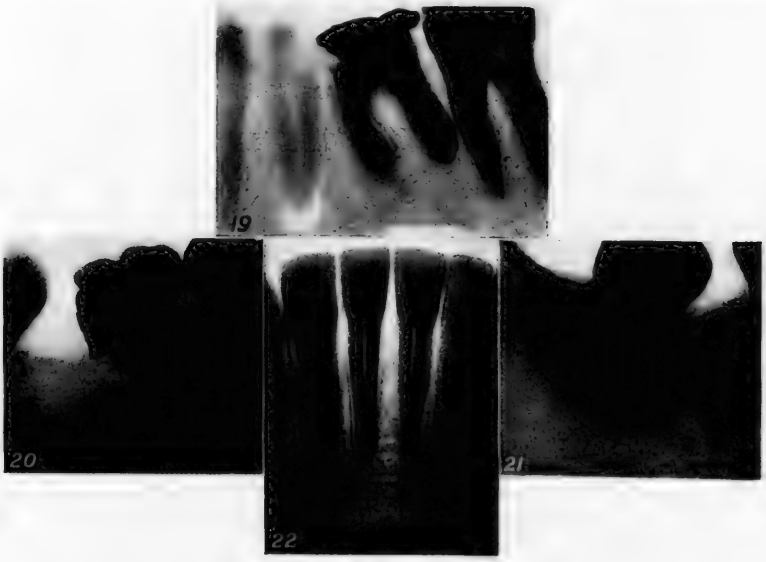
FIG. 22. Radiographic evidence of early periclasia around left central before any gingival inflammation was clinically visible; namely, abrasion of incisal edge, cervical pericementitis, destruction and atrophy of interproximal bone, hyperplasia of peridental lamella.

PLATE 5

FIG. 23. Effects of traumatic occlusion with deposits of calculus. Marked definition of the occlusal lines on the lingual aspect of molars and bicuspids, absorption of interproximal crests, calcareous changes in the pulp, generalized thickening of peridental membrane with proliferation of the peridental lamella, generalized atrophic alveolar degeneration.

FIGS. 24, 25 AND 26. Effects of traumatic occlusion in upper and lower anterior teeth in the same patient. In these specimens there are no deposits of calculi, but in figure 24 there is a pericementoma at the apex of the central.

FIG. 27. Traumatic occlusion produces hyperplastic bone changes in the alveolar process around molar and few bicuspid areas, but atrophic changes are found around centrals, laterals, cuspids and some bicuspids.



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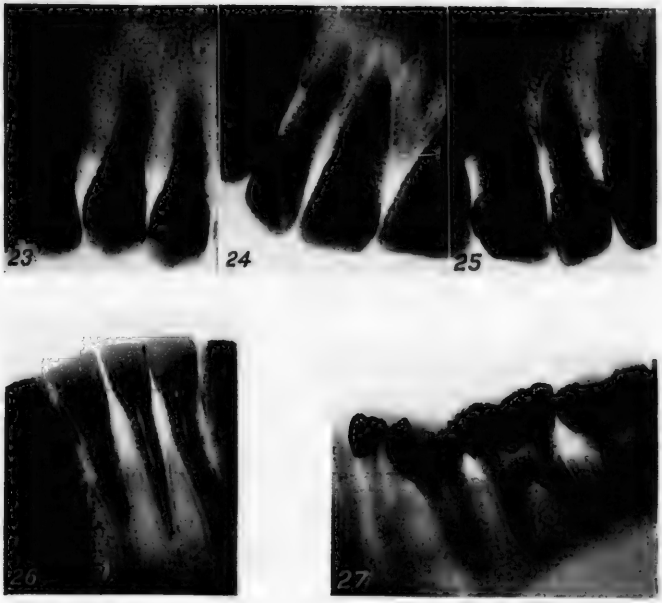

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(Pollia: Radiography in Early Dental Disease)

PLATE 6

Varieties of pathological changes in edentulous areas

All of these radiographs were taken not less than two years after extraction.

FIG. 28. Retained pericementoma with infective osteomyelitis.

FIG. 29. Infective osteomyelitis.

FIG. 30. Retained needle point the cause of vague choking sensations.

FIG. 31. An unerupted molar with a rudimentary supernumerary tooth, the reasons why a lower plate was painfully uncomfortable.

PLATE 7

Edentulous pathological areas produced by the extension of inflammation from defective restorations

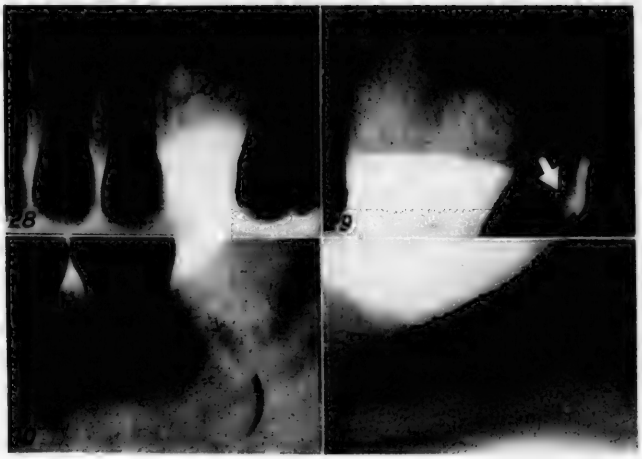
FIG. 32. Atrophic changes with retained pericementoma.

FIGS. 33 AND 34. Marked bone atrophy from inflammatory agencies present beneath restorations.

PLATE 8

FIG. 35. Normal edentulous bone regeneration.

FIGS. 36, 37 AND 38. Normal regeneration of bone tissue under saddles; numbers 36 and 37 are under Chayes type saddles, and 38 under the Peeso type.



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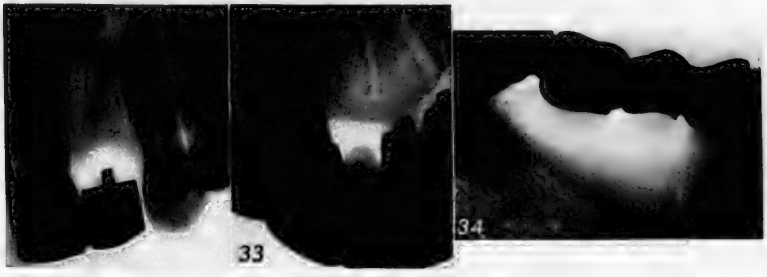

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(Pollia: Radiography in Early Dental Disease)

THE ENDOCRINES AND PREVENTIVE DENTISTRY[1]

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INTRODUCTION

Confucius, the great philosopher, tells us, "Study the past if thou wouldst divine the future." How true this is! To solve the mysteries of existing conditions and prepare to meet future exigencies, one must familiarize himself with the past. The student of the affairs of today must seek for explanations in the events of yesterday; the political economist must learn the economic problems of previous ages before he may comprehensively grasp his own; and the student of political history has to delve into the archives of the past to cope successfully with the present.

Just as it is with the world at large, so it is with man, the eternal problem of the physician and the dentist. To fathom the idiosyncrasies of this generation, one must realize that a man of today is merely the summation of processes that have gone on since life first existed, that he is the culmination of biological viscissitudes. To understand man and intelligently study him, we must know fully his past history; and his history extends beyond the individual, it extends beyond his parents and beyond his grandparents; it is lost in the dim obscurity of the past. In a word, we must appreciate the factors of inheritance if we, physicians and dentists, are to attack a problem intelligently. It is my purpose this evening to treat the relationship between prophylactic dentistry and the endocrine glands with this broader vision in mind. I shall make no reference, therefore, to the ordinary topics of dental prophylaxis universally advocated by your honorable profession, and shall omit from my discussion such subjects as oral hygiene, mouth infections, traumatisms, reconstructive methods and similar matters connected with common prophylaxis.

[1] Read at a meeting of the First District Dental Society of the State of New York, New York Academy of Medicine, October 2, 1922.

An initially perfect set of teeth of normal chemical composition and structure, in a person with normal constitution, will ordinarily require no prophylactic attention, and will last for a life-time and more. I know of numerous instances, and your experience will verify my statement, where people have never known nor used the simplest prophylaxis, and yet their dental apparatus is perfect. On the other hand, I know of others who utilize every prophylactic measure suggested by progressive dentistry and yet their teeth suffer decay and destruction. Such instances are not rare; they are common, every-day occurrences, as Chayes (1) has already pointed out. Why does this occur? How are we to explain these phenomena? The answer is: inherited constitution and metabolic processes.

These two great factors dominate the eruption, development and life of the teeth, and point out to us the true places where rational dental prophylaxis must begin, if effective results are to be obtained. These two factors, inheritance and nutrition, must receive our consideration.

CONSTITUTION AND INHERITANCE

Constitution and inheritance go hand in hand; metabolism and nutrition are interdependent; upon these two fundamental factors, a perfect and lasting dental apparatus depends. One of the fundamental laws of nature, as Darwin (2) recognized long ago, is the variation in individuals; no two organisms are exactly alike. Even the so-called identical twins, which to the ordinary observer appear to be practically alike, have been shown by Galton's (3) researches to be really very different from each other. Normal persons have apparently the very same number and kind of organs, and yet there is something peculiar to each which distinguishes him from all others. These distinguishing marks may be variations in size, height, weight, bulk, complexion, shape of the visible organs, the color of eyes and hair, the type of trichosis, the mental characteristics, talents, idiosyncrasies, and also the teeth.

All of you whose lifework brings you in every-day contact with the cavum oris have long ago observed that the teeth of human beings, like those of the lower animal groups, differ considerably as to size, shape, strength, position, color, longevity, tendency to decay, etc.,

and this in accordance with the natural laws of variation. Certain kinds of teeth are characteristic of certain individuals and are in accordance with their constitutions. Constitutions are inherited, such teeth are also inherited. Heredity plays a most important rôle in the formation of teeth, as of every other organ. By heredity is meant, according to Davenport (4), "the recurrence of traits in a number of blood relatives due to their possession of a common germplasm. Hereditary traits are those whose development depends chiefly upon germinal factors, genes and determiners." Whether the heredity is direct, atavistic or collateral, or whether it is of the similar or dissimilar type, dominant traits are transmitted from generation to generation, according to the Mendelian laws. These dominant traits may express themselves either in some physical manifestation, such as peculiarities of physiognomy and anatomy (peculiarly shaped nose, projecting ears, receding jaws, birth marks, polydactylism), or in certain mental characteristics, good or bad (mathematical genius, musical ability, extraordinary memory, idiocy, feeble-mindedness, perversions, criminal tendencies, etc.), or in inherent inclination to disease, such as epilepsy, hemophilia, carcinoma, tuberculosis, insanity, etc.

Peculiarities and abnormalities of teeth also conform to the Mendelian laws. Certain characteristics of teeth may be observed in successive generations or in the individual members of a whole family. McQuillan tells of a family where father, son and grandson lacked the upper lateral incisors; in a second son these incisors were exceedingly dwarfed and in some of his children so stunted that they were unsightly. The total absence of the last molars is a common occurrence, and even absence of the entire set of teeth has been observed as a familial trait. Several such cases of edentulous families are on record. Supernumerary teeth, faulty enamel, and non-eruption of individual teeth, are also familial defects obviously due to an inherited faulty germplasm. I have had many opportunities to observe children and their parents with non-erupted teeth, and in two cases, according to their histories, this condition probably existed in the grand- and great-grandparents.

In order to understand familial transmission, we must answer the question: By what mechanism is the transmission of inherited char-

acteristics achieved? In the light of our present knowledge this question cannot be definitely answered; and yet a careful analysis of the process of reproduction permits one to entertain certain rational conclusions. Let us start from the meeting of the ovum and spermatozoon, the beginning of an individual life. After the complex process of maturation is completed, the so-called zygote, or the fertilized ovum, is formed from the mature ovum and spermatozoon. Fertilization differs in its details in all animals, but in its essence it consists of the union of the nucleus of the spermatozoon with the nucleus of the ovum. At the time when the spermhead enters the egg its chromatin network is extremely dense and compactly arranged, but soon its change into a typical nucleus—the male pro-nucleus—makes the spermhead to all appearances similar in structure to the female pro-nucleus which originates in the egg. The chromatin networks of both nuclei then pass into the next stage, the spirene, where the chromatin particles are lined up in the equatorial plane and divide to form the chromosomes. The cell is now ready to split into two daughter cells by gradual constriction of its cell wall and equal division of the protoplasm surrounding the chromosomes. From this time multiplication continues at a rapid rate, the cells changing in form, location, and special function, until they form the three main blastogenic layers, the ecto-, meso- and entoderm, from which all the organs finally originate. From the moment that the head of the spermatozoon passes through the micropyle into the ovum, it has carried with it all that the paternal side may contribute to the destiny of the future individual. On the other hand, all the potentialities transmissible from the maternal side are deposited in the future offspring through the female pro-nucleus. The fate of the future individual is thus sealed at the moment when fertilization is complete, i.e., when the male and female pro-nuclei fuse to lay the foundation for the first two daughter cells.

That all potentialities are contained somewhere in the germplasm, since this is the only connecting link between two consecutive generations, must be, and is, admitted by all. It is the germplasm which carries therefore the "Anlagen" for the future endocrine glands, that later determine the constitution of the future individual. It is here where "every particle of protoplasm, every granule of the impregnated ovum carries within it the essence of the parental ductless glands, and

with it all those elements which transmit to the offspring the racial, national, and atavistic characteristics of its progenitors. They endow the child with all the phenomena we commonly interpret as inherited. They determine those unique facial features which later identify the offspring as Caucasian or Mongolian, Scandinavian or Italian, Gentile or Jew. They serve as foundation stones upon which the future tendencies, mental aptitudes and pathologic predispositions are built" (5). Morgan (6) has probably located within the chromosome the exact position of each potential specific organ reproduced during the later period of embryonal development. It is not improbable that the particular chromosome particles attributed by Morgan with power to create specific organs accomplish this task by being incorporated into the "Anlagen" cells, productive later of the various endocrine glands. When these are formed, they then assume the direction in the construction of the other organs, each dominant gland according to its own architecture. This results in the origin of individuals of definite endocrine types or constitutions, determined primarily by the inherited potentialities from father, mother, and their progenitors, and secondarily by the character of the architect, the controlling endocrine gland.

CONSTITUTIONAL TYPES

In speaking of constitutions, we must in the light of our present knowledge abandon our old classifications and turn to the newer one, based on physiological principles, i.e., classification by endocrines. The medical profession has learned lately to differentiate individuals according to these endocrine types or tropisms (7), according to the direction of development which the individual assumes from the very early embryonic period to full maturity. This tropism determines all his characteristics, his physiognomy, the form of all external organs, the functions of the internal organs, his mentality, character and other peculiarities which serve to distinguish him from others. His tropism prescribes also the type, position, development and character of his teeth. Long or short teeth, bulky or slender, clear-colored or stained, rounded or flattened, crowded or spread, normally or irregularly placed, long or short lived, are only a few of the characteristics which depend upon the tropism of the individual. Further clinical study has led to a subdivision into types: the true—the thyrotrope, pituito-

trope, and adrenotrope; and the mixed—a combination of two or more of these. Individuals of each type have certain common features which enable one familiar with endocrine functions to differentiate one type from another as easily as one may identify the breed of an animal.

Skeptics in the medical profession are inclined to deny the inherent powerful influences ascribed to the endocrines and exerted by them upon growth, development, sustenance and function of all organs, including teeth, and this in spite of the abundant evidence already on hand and increasing daily. To disregard it is folly; to overlook it, an excuse only for the willfully blind. It is true that the study of endocrines is still comparatively new and that much is yet to be learned. Nor is it denied that some of the statements made in regard to the endocrines do not bear close scrutiny. Nevertheless, the mass of clinical, laboratory, experimental, and pathologic evidence so far accumulated is so enormous that one with an open mind and clear vision can no longer fail to perceive the fundamental rôle played by the endocrines in the animal economy. Their far-reaching influences become particularly vivid when the endocrines, through disease or nutritional disturbances, become deranged in function. It is then that numerous perversions occur during which many distant organs must bear the brunt of the powerful upheaval caused by maladjustment of endocrine functions. Take, for example, the changes that occur in acromegaly, a disease of the pituitary, in which a perfectly normal being with organs of appropriate build and function, of good mentality and of social value may be transformed into a hideous, disproportionate being of low mentality and perverted function—a social burden. Perfectly beautiful teeth become, under such circumstances, huge, disproportionate, grotesque, and are displaced, spread apart, etc. Is there a disorder ascribable to any other organ than endocrine where such transformations ever occur? Is there anything more striking than the changes brought about by such diseases of the thyroid as myxedema and exophthalmic goitre? Or is there anything similar to the symptomatology of eunuchoidism and like gonadal disturbances? No pathologic conditions affecting other than endocrine organs have such widespread and astonishing symptomatology. Examples sufficient to fill volumes might be quoted to demonstrate

the powerful control and influence, physiologic and pathologic, wielded by the endocrines over all organs and functions, including the teeth as well.

ANTE-NATAL PROPHYLAXIS

As the endocrines are some of the earliest structures to originate within the embryo, the Anlage of the thyroid, for example, appearing when the fetus is only 5 mm. in size; and as their dominating powers, soon to be exerted upon the development of the other organs, are partly inherited but also partly molded by maternal conditions; it is inevitable that any prophylactic measures that are competent to direct endocrine behavior in ways which favor the development of a good dental apparatus must be inaugurated very early indeed. The inherited paternal characteristics can no longer be changed, but the maternal inheritance is still to some extent within reach of regulation. Hence it is self-evident that in order to apply effective and intelligent prophylaxis, the dentist must begin early, with the pre-natal stage, the embryonal period. To emphasize this point permit me to recall to your attention, in short, the embryology of teeth.

Teeth are derived from two fundamental tissues, the ectoderm and mesoderm (8). The earliest manifestations of the dental tissues appear on the thirty-fourth to fortieth day, when the embryo is about 11–12 mm. in length, presenting at that time a thickening of epithelial tissue in the processes bounding the premature mouth. This is followed in the seventh week by the formation of the labio-dental lamina and its subdivision into the labial and lingual strands. From the dental shelf, or common dental germ which appears as an oblique evagination in the ninth week, inequalities develop with ten protuberances, the special dental germs, the progenitors of the upper and lower milk teeth and also of the later permanent teeth. In the tenth week the mesodermal tissues surrounding the sides of these protuberances become more and more condensed, and grow into the epidermal layers forming the dental papillae. Thus we have the origin of the substantia eburnea, the substantia adamantina and of the pulp. The dentine and pulp form from the masses of mesodermal tissue, the dental papillae and the enamel from the outer epidermal layer. Blood vessels and nerves ramify through all parts of the dental papillae,

which soon begin to specialize and differentiate. The inner mass remains single and forms the pulp, but the layer of cells contiguous to the enamel develops into a single layer of columnar cells, the odontoblasts, which influence the deposition of lime. In the meantime, the common alveolar socket is formed, but this is very soon subdivided into a number of loculae to form sockets for the individual deciduous and permanent teeth. Calcification is now going on at a rather lively rate and tiny channels of odontoblasts, the dentinal channels, anastomose and combine to form the dentinal fibers. At about this time cement appears at the roots of the teeth. The successional permanent teeth that replace the deciduous set originate at about the same embryonal period as the milk teeth; only the super-added three permanent molars appear somewhat later.

These few embryological data are enough from which to draw several important conclusions and are presented with this object in view. In the first place, it must be remembered that during the first three or four months of embryonic life the foundation for all teeth, deciduous and permanent, is laid. In the second place, it must be realized that these embryo teeth are highly susceptible to their environments, and that they are delicate and plastic structures easily moulded and affected by surrounding circumstances. Finally, we must bear in mind that their wonderful development takes place within a very short time. The conclusion must indeed be brought home to us, then, that, in these first four months of gestation, prophylaxis to insure normal functioning in the mother is vitally necessary to the attainment of good health and teeth in the child. It follows therefore, that it is urgent to supervise the physical condition of a mother not only from a pathological viewpoint, for fear of possible dystocia, labor complications, post-partum sequelae, etc., but it is also obligatory to observe the patient from an endocrine viewpoint and to discover dyshormonisms or metabolic faults which may affect the health and development of the future infant. It is our solemn duty to guard our posterity from physical defects and mental or psychical inferiorities, if this can be accomplished. It is obligatory upon every medical attendant to see that every pregnant mother should during her early months of gestation, in addition to the ordinary care and attention, have her faulty endocrine functions corrected and prophylactic meas-

ures instituted accordingly. If correct nourishment, rest, proper hygienic surrounding, healthy mental atmosphere, the avoidance of grief, worry and excitement exhaustive to the endocrines, will prevent or correct dyshormonisms, it is the duty of the medical man to recommend these and have them attended to. Already in the second month of gestation, when the first Anlagen of the future teeth appear, he must pay attention to the pregnant woman and all correctible difficulties occurring during this critical physiologic period should be disclosed and removed. The pituitary, which enlarges during pregnancy in order to meet the extra demands made upon it to three and four times the normal size, must receive foremost attention (9). The hypophysis in the female is a highly developed organ and is closely connected in physiology and morphology with menstruation, pregnancy, labor, lactation and sexual function. In the child the pituitary is influential in the development of the teeth and determines their size, bulk, periods of eruption, position, the shape and size of the alveolar processes, etc. A normally functioning pituitary is a prerequisite to the development of good teeth in the child; a dysfunctioning gland, either in the mother or child, is a common cause of faulty dentition in the latter. Non-eruption, late or irregular eruption, malformation, undersize, displacement, spacing, etc., are some of the results of such dysfunction. Hence, prophylaxis to assure normal pituitary function is necessarily indicated.

The thyroid plays a no less serious part in the life of the woman. The gland's activity is increased during each menstrual period and during gestation. It also takes a part in the history of dental development. A good, properly-functioning thyroid in the mother is no small factor in endowing the child with well-shaped, normally formed, appropriate, perfectly enameled and clear colored teeth. The other endocrines also play either major or minor parts in the development of the dental apparatus, as in that of every other organ.

The medical man who undertakes the care of a pregnant mother nowadays should feel that he has more to do than merely to watch the urine for albumin and the fetus' position in utero. It is deplorable that many obstetricians neglect the use of proper prophylaxis during the pre-natal period of the child's life, and do not yet realize the obligation placed upon them of helping to mould the future in-

dividual into a more perfect being, prepared to meet the tasks and hardships of modern life.

CALCIUM METABOLISM AND ENDOCRINES

Let us now consider the post-natal era, when an additional factor steps in to take an active part in the development, sustenance and life of the teeth. Metabolism, or nutrition, is this other factor. But, as will be shown later, endocrine activity again enters here as a factor, as it regulates metabolism. Hence the glands of internal secretion are, after all, the governors of every vital process, including circulation, respiration, digestion, excretion, secretion, energy regulation, nutrition, at all periods of life, pre- and post-natal. Indeed there is no process of life which is not somehow dependent upon endocrine activity, being influenced either directly by the hormones or indirectly through the nervous system, which the hormones also affect. Faults in metabolism are the cause of many abnormalities. To discuss all here would be impossible. I shall confine myself therefore only to one phase of metabolism, that of calcium, an element vital to the life of the teeth.

Calcium is as necessary a constituent of every animal cell as an electrolyte in a battery. A cell without calcium is without life; an excess of this constituent exaggerates cell reactivity. Some tissues, bone and teeth for example, require large amounts of calcium salts, bone about 80 per cent; dentine, 72 per cent; enamel, 96.5 per cent; others demand it in smaller quantities. Calcium occurs in the organism in combination as phosphates, carbonates, fluorides. These combinations are poorly soluble in water, and are situated besides in surroundings (gelatinous) which make their diffusibility more difficult. It is not improbable that this element exists in tissues in a polymerized combination similar to glycogen, which is derived from dextrose. Dextrose ($C_6H_{12}O_6$), a crystalline and very soluble, polymerized substance necessary for energy production, is converted by the loss of H_2O into glycogen, an amorphous polysaccharide forming only colloidal solutions and not diffusible through animal membranes, so as to assure a retentive form, adapted for storage and use when required. The same process probably occurs with calcium; for transportation and absorption it is in a suitable diffusible form; for storing in cells

and tissues, in a less diffusible and more retentive state. For this transformation from one form to another, a ferment is most probably provided by the parathyroids; and it is here that the highly important function of these glands concern the metabolism of calcium.

In addition to being stored for emergency service and as support in bones and teeth, calcium plays an important rôle in the irritability of nerve tissue. Such conditions as tetany, spasmophilia, convulsions, intestinal insufficiency, tics, muscle spasms, asthenia, constitutional debility, etc., are now known to be associated with, if not due to disturbance of, calcium metabolism. In rickets and osteomalacia there is also calcium disturbance. In calcium impoverishment the organism is forced to economize on this element in carrying on its most vital functions. Calcium hunger is debility, every cell of every organ needs calcium and, according to Loeb, no cell metabolism is possible without this absolutely indispensable mineral. The adult needs it for cell activity; the young needs it even more, not only for cell activity, which is at its height during this period of life, but also for the growth and development of skeletal tissues, teeth, nerves, etc. For this reason disturbances of calcium metabolism in childhood are a particularly serious matter, giving rise to such grave complications as retardation of growth, poor development of teeth, bone, cellular tissues, an irritable nervous system, and disturbances of other organs making strenuous demands for this substance.

How is calcium supplied to the organism? In utero the fetus obtains it from the maternal blood. If this is poor in calcium salts, the natural growth and development of the fetal tissues particularly in need of this element are sure to suffer. It is evident therefore that it is important to maintain the equilibrium of calcium in the pregnant mother from whom the supply is obtained by the developing child. This is necessary in the interest of both mother and child. If the infant drains the mother's natural supply then her bone calcium reserve will be depleted and osteomalacia or other diseases brought about by calcium impoverishment will appear. In the child with an inadequate calcium supply poor teeth, bony deformities, a deficient nervous system and similar pathologic phenomena will be the result. Prophylaxis instituted to prevent calcium poverty may not only save the health and constitution of the mother, but may provide the still

unborn child with the necessary material for its normal dental and osseous systems and a nervous tissue of proper stability and responsiveness.

In the post-natal period, the calcium supply is obtained from the food. But is all ingested calcium absorbed and utilized in the human economy? Does all calcium administered for therapeutic effect enter the blood current and is it delivered to places where it is needed? Can calcium absorption and assimilation be regulated by prescription? These are questions of importance, for if it were possible to control calcium absorption, the question of its impoverishment with its consequential diseases would be solved. Unfortunately, calcium absorption and metabolism are not yet within the control of the physician. It requires something more than mere feeding to overcome calcium demineralization. The endocrines have also a say in this vital question.

Three endocrines appear to have a direct influence upon calcium metabolism: the parathyroids, the thymus, and the sexual glands. Let me quote here a few data which may be of interest and later can be used for deductions. (*a*) If we test a frog nerve-muscle preparation for its electrical reactions and then immerse it in a diluted oxalic acid solution to diminish its calcium content, we soon find that its electrical response will occur at a very much lower threshold. (*b*) If one of the limbs of a living dog is transfused with another dog's blood, from which calcium has been removed by diffusion with a calcium-free liquid, an increased susceptibility of the galvanic current will be obtained. (*c*) If a frog muscle-nerve preparation or a frog heart is transfused with blood from cats whose parathyroids have been removed, then the contractions become more responsive and lowered. The same phenomena occur when such specimens are treated with calcium-free Ringer solution. These experiments show that blood poor in calcium salts increases neuro-muscular irritability and that blood of parathyroprivae animals, though containing calcium, acts as if this element were absent.

A few other phenomena: (*d*) After the removal of the parathyroids, tetany and other diseases characterized by spasmophilic tendencies occur. They are brought about by calcium impoverishment of the blood due to excessive elimination of this element in urine and feces

of the operated animals. (*e*) Parathyroidectomized animals, if they do not succumb to more serious affections, will exhibit such symptoms of muscular hyper-irritability as spasms, convulsive tics, contractures, etc., if subjected to the slightest stimulus. (*f*) Metabolic investigations of parathyroidectomized animals always show a negative calcium balance, i.e., the excretion in the urine and feces is greater than the intake. Analysis of the ashes, after combustion of the whole of these parathyroidectomized animals, shows a great reduction in total calcium as compared with the total amount in a normal animal. (*g*) In parathyroidectomized animals the bones are soft and brittle, and when fractured callus formation is poor or absent. (*h*) The electrical stimulation of the ulnar nerve in the normal human being results in a C.C.C. contraction at 0.9 millamp., and the A.O.C. at 2.5 millamp. In hypoparathyroidal states the irritability of this nerve is so much increased that it reacts at 0.1 millamp. in the C.C.C., and in the A.O.C., at even less. (*i*) The teeth in parathyroidectomized animals are peculiarly affected. When the glands are removed before sexual maturity, for example, in rabbits at the age of six to ten weeks, if the animals survive long enough, there will appear on the anterior surface of the teeth, especially the canines, white milky spots which move toward the biting edge as growth progresses. These are due to poor calcification of dentine and the absence of enamel. The teeth break easily and ulcerate. If other parathyroids are transplanted (but not if fed) the evidences of calcium insufficiency disappear and only small defects remain. As no other course but parathyroid transplantation reëstablishes normal dental conditions, it proves that functioning parathyroid glands are essential for the proper reëstablishment of normal conditions in the animal's teeth.

All these data are offered to illustrate the intimate connection between the parathyroids and calcium metabolism, and the dependence of teeth, bones and nervous system upon the normal functioning of this gland. Not only is this fact substantiated by a mass of experimental data derived from animals, but it is revealed daily in human beings in the clinic. It seems probable that the parathyroid hormones facilitate the transformation of calcium into a form that prevents its being too rapidly diffused and eliminated, and enables it to be stored for the future needs of the organism. It apparently helps to

convert the useless calcium into an absorbable and assimilable form, and to make it accessible to all cells dependent upon it for their activities. Whether the nature of its hormones is that of vitamines, or of protein-splitting or other kinds of ferments, the fact still remains that the parathyroid hormones are instrumental in normal calcium metabolism and its vital phenomena.

The thymus is another organ wielding an influence over calcium metabolism. If the thymus is removed in young, sexually unripe animals, their bones, especially the diaphyses of the lower long bones, soften, become knotty and swell near the epiphyses; bone calcification is also suspended; the animal's calcium balance assumes a negative direction and the calcium contents of bones and tissues diminish. The administration of calcium compounds or feeding with thymus has no effect upon these pathologic disturbances. It is thus the *living* thymus that plays an integral part in the metabolism of calcium, though perhaps not as great as the parathyroids, thymus loss cannot, therefore, be made good by a powder from its dead substance. As the thymus is in its prime throughout the period of childhood, when post-natal calcification of teeth is being effected, and relinquishes its function only at maturity, it is palpable how essential a normal thymus is during this period. Disturbed activity of the thymus will react upon the health of the teeth, especially the permanent ones, for during this period of gland activity their calcification is in progress. The first permanent molars calcify soon after birth, the incisors and canines get their mineral supply six months after; the pre-molars harden during the second year of life; the second molars at the end of the second year; the wisdom teeth become calcified in the twelfth year when the thymus is about to retire in its function to make way for the sexual organs entering into their dominating period, adult life.

That the sexual organs also have a hand in calcium metabolism may be seen from the effect produced by their removal in osteomalacia. In this disease, which usually affects pregnant women and is marked by decreased level of calcium in the blood, great increase in the excretion of this mineral and of phosphorus in the feces and urine, and disappearance of the salts from the pelvic and long bones with their softening and distortion, the influence of the gonads upon calcium metabolism is brought to light. The interstitial cells of Lydig, which are

numerically increased in pregnancy, fail to undergo involution in cases of osteomalacia; and their destruction, when the ovaries are removed, is followed by remarkable improvement in the patient. Most of the symptoms are ameliorated and the calcium contents of the blood is re-established to a normal equilibrium—all of which tend to disclose the relationship of the gonads to the metabolism of calcium.

It is not far-fetched to conclude from the above and many other very carefully studied observations that calcium metabolism is influenced by the parathyroids chiefly, and by the thymus and the gonads to a lesser extent. Perhaps the other endocrines may also share in this vital process, vital especially during the dental formative period. Without a requisite amount of assimilable calcium, teeth cannot long maintain a normal wear and tear. The calcium equilibrium must be maintained under all circumstances, first in the pregnant mother for reasons already stated, and second in the growing child, which ordinarily has a small calcium reserve and requires a large supply of this substance for its development.

The endogenous calcium supply to the child's organism may be achieved by paying attention to the following points: (*a*) The proper supply of exogenous calcium in the mother's milk and later in the food of which the child partakes during its dentition period. (*b*) Good gastric function with normal production of hydrochloric acid, which is necessary for the proper digestion of calcium-containing foods. (*c*) Good intestinal absorption, without which the calcium may never enter the circulation and reach its place of destination. (*d*) Correct functioning of the parathyroids, thus inhibiting calcium lysis. Faulty glandular action is very detrimental but may be readily recognized and not infrequently corrected.

CONCLUSIONS

We must all admit that medicine and dentistry are inseparably linked. The dental apparatus has the same status in the general welfare of the body as every other organ which is of concern to the medical man. Good teeth are essential to good health. Good teeth can be had only in a healthy body with a normal constitution; hence, the interdependence of good teeth and the other organs comprising a normal constitution. Unfortunately, this fact is not universally

recognized. Many of our medical colleagues regard the dental apparatus as of inferior importance. They fail to recognize the teeth as possible causes of the ailments they are called upon to treat. Some hardly care to glance over the teeth during an otherwise careful examination of patients. Indeed it is only a decade or so since any medical man gave thought to the teeth, and it was only the investigations of Rosenow and others, who demonstrated the true relationship between apical infection and many of the hitherto unknown constitutional disturbances, that induced physicians to pay some attention to the dental apparatus. Nowadays the true diagnostician never gives his opinion until he has fully familiarized himself with the patient's teeth, either by consultation with a dentist or through radiographic study or, at least, by personal inspection. It is not uncommon any more for a patient to be directed to his dentist when the family physician finds conditions in the mouth warranting attention. Such professional coöperation in the interest of the patient is greatly to be commended and let us hope it will be more widely extended.

On the other hand, many dental men do not sufficiently realize the necessity of studying the general health and constitution of the patient whose teeth they are treating. Almost all pathological changes affecting dentures occur because of some constitutional inferiority. Many have an underlying, general causative factor which must first be detected and eliminated before any permanent or even partially satisfactory results are achieved by local therapy. The tooth, like every other organ, is dependent upon its nourishment, supplied by the circulating fluids surrounding its roots. The quality of the material supplied and the rapidity with which the waste is removed, both of which are accomplished by the immediate circulation, determine its nourishment. The composition of the blood is subject to variations and depends upon the condition and functioning of every distant organ. If the blood is vitiated by diseased, distant organs, the teeth will be unfavorably affected. But, if a good, healthy and nourishing blood supply, free from abnormal additions or alterations in quantity or constituents, reaches the teeth, then these organs will thrive most readily. Appreciation of this relationship makes it easy to comprehend how much the welfare of the teeth depends upon the state of the rest of the body. Dentists must realize this fact; they must see further

than the tooth. Of course such factors as bacteria, trauma, mechanical, chemical and thermal agencies, etc., to which teeth are subjected, also have a bearing, but the consequences of these depend upon the environment of the tooth as determined by the general state of the patient rather than by the local cause alone. Therefore, dentists must not forget the individual whose teeth they are ministering to; they must make sure that a constitutional disturbance does *not* underlie the local pathology; that a local decay is *not* merely an expression of another general disease. They must understand that the best mechanical correction under such circumstances is but a temporary affair soon to become useless and cumbersome, if not dangerous. It is not expected, of course, that the dental man trained in his particular specialty should be prepared to diagnose and correct bodily ailments foreign to him. This is unnecessary. It is only intimated that he must keep in mind probable constitutional causes underlying the local conditions observed by him in the oral cavity; that he must endeavor to have these discovered and corrected when present. This should constitute an essential aim in his efforts for the best interests of his patient and may be accomplished by his coöperation with the medical man.

In this, our age, when all are coming to realize the wisdom of the proverb that "an ounce of prevention is worth a pound of cure," dental prophylaxis has come to occupy the prominent position it is entitled to. Good teeth are an asset. Without them proper mastication and digestion are lacking and consequently the health suffers. On this account the whole energy of the sufferer, his ambition and productive capacity, may be lessened with a material and moral loss to the community and to his family in particular. The decay of teeth is so extremely common that when one studies the statistics he is amazed by the magnitude of the figures. Even our younger generation, as the school census proves, is most alarmingly affected in this respect. The urgent need of prevention of dental caries is recognized even by governments. In England not long ago the Minister of Health, together with the Medical Research Council, appointed a committee consisting of the most eminent physiologists, pathologists and authorities in dentistry to study the dreadful situation. In a lecture delivered on public dental health at the British Dentists'

Hospital, Dr. Harry Campbell expressed himself frankly in speaking of the teeth of the British people by saying: "We have the worst teeth in the world." He estimated that in England at least one hundred million teeth had been extracted, while another hundred million teeth had been spontaneously shed, and the number of decayed teeth he estimated at about two hundred million. He thought that diseases of the teeth were for the most part due to faulty dietetic customs and to that extent they were preventable. He asserted that the shedding of the teeth in old age was not a senile change; with healthy sockets the teeth, far from loosening with advancing years, become more firmly fixed. He declared the British people had lost the art of mastication; "they didn't chew, they sucked their food."

Conditions in this country are not much better and it is incumbent upon the two professions, the medical and the dental, to combat this very serious circumstance. While it may not be possible to accomplish for the present generation all that we desire, it is our duty to look ahead and do what we can for the next. Much can be done if we bear in mind the laws of nature, the laws of inheritance, the influences of the endocrines and the processes of metabolism. Also if we devote our attention to the pre-natal period of the future generation, we may expect progress in dental prophylaxis. A careful constitutional analysis of parents, particularly of the mother during her gestation period, and the elimination of complicating dyshormonisms will accomplish a great deal in that direction.

Let us, medical men and dentists, go hand in hand and do our duty. Let us coöperate. Let us study every individual case we meet and give it the best that is in us. Let us apply every therapy at our command, even if it still be imperfect. Let us work diligently so that our imperfect means of alleviating, curing, or preventing disease may become more perfect. Let us all work together for the benefit of humanity and future prosperity.

REFERENCES TO LITERATURE

(1) CHAYES, H. E. S. 1918 Technic and scope of cast gold and porcelain inlays.
(2) DARWIN, C. The origin of species: Variation of animals and plants under domestication.
(3) GALTON, A. Natural inheritance.
(4) DAVENPORT, C. B. Papers on heredity and eugenics.

(5) GUTMAN, J. 1920 The ductless glands and constitutional diagnosis. *Medical Record*, April 3.
(6) MORGAN, T. H. A critique of the theory of evolution.
(7) KAPLAN, D. M. 1917 An endocrine interpretation of the dental apparatus. *Endocrinology*, April.
(8) BAILEY AND MILLER 1921 Embryology.
(9) GUTMAN, J. 1921 A study of high blood pressure in women from the endocrine standpoint. *New York Medical Journal*, July 6.

DISCUSSION

John Rogers, M.D. (New York City): You are indeed fortunate in having had this paper presented to you this evening. The subjects of physiology, anatomy, pathology and therapeutics seem to be growing more complicated every year, and perhaps the best service I can render you is to try to simplify the diagnosis and treatment of endocrine disease.

Dr. Gutman's presentation of the subject outlines many disorders which have been more or less definitely traced to abnormal functionation on the part of the endocrine glands. But, at present, effective treatment can be applied only to those which are caused by the thyroid, and possibly by the ovaries and the adrenals. The thymus, the parathyroid and the pituitary glands evidently have much to do with the biochemistry of calcium and the elements in the series most closely allied to it. We know, in addition, that sudden death either with or without a preceding anesthetic, or some other inadequate cause, is associated with an enlarged thymus; that tetany, or an excessive irritability and spasmodic condition of the muscles, is sometimes caused by deficient functionation of the parathyroids, and can be relieved by intravenous injections of solutions of calcium and sometimes by parathyroid feeding; that acromegaly, with its giant growth chiefly in the bones of the face and hands and feet, is due to a chronic overactivity of the pituitary gland; that a failure of the islands of Langerhans in the pancreas causes diabetes and that an extract (insulin) from these islands helps the body to utilize sugar; but we know very little more about these organs, and practically nothing about the treatment of their chronic dysfunction. It has been said that the inorganic elements are present in the body in the same proportion as they existed in the paleozoic ocean, and any variation in this proportion causes disease. It is not known, however, that the endocrine organs are instrumental in keeping the relative proportion of the elements in a correct balance. The adrenal glands are essential for the maintenance of life. Their slow destruction by tuberculosis causes the slow death of Addison's disease. But their immediate destruction is followed by a quite different and rapidly fatal train of symptoms. There

must be many chronic disorders which will sometime be traced to a partial failure of the adrenals, though as yet they are unrecognizable. We know only that the common solution of adrenalin is a good styptic, a useful stimulant for an acute heart failure, and relieves but does not cure the paroxysms of some kinds of asthma. Adrenalin seems, however, to be only a part of the active principle of the whole gland, for it will not benefit the chronic Addison's disease nor the acute symptoms which follow the sudden destruction or removal of both these organs. Furthermore, extracts of the entire adrenal stimulate much more vigorously than adrenalin, the "check" upon the secretory activity of the viscera which is exerted by the sympathetic portion of the involuntary nerves. When the viscera functionate too vigorously, as in palpitation of the heart or in gastric hyperacidity or in some diarrheas, help can often be given by feeding derivatives of the whole gland, such as the commercial adrenal nucleoprotein tablets or the liquid adrenal residue. These preparations are also entirely harmless. If the thyroid cannot obtain, or cannot utilize, a certain minimum amount of iodin, it responds by enlarging, and the resultant "goitre" is apparently an hypertrophy to compensate for excessive demands for the gland's product. This promotes the general process of oxidation and stimulates the drive to the viscera which is conveyed in the autonomic part of the involuntary nerves. In hypothyroidism there is generally a thyroid enlargement and a manifest failure of vigor or "drive," with a quiet heart and inactive viscera. In hyperthyroidism there is too much drive, with an overactive heart and overactive viscera and overactive nervous system. The hyper state seems to develop after a preceding hypo condition. The chief danger in thyroid feeding, which is the proper treatment for hypothyroidism, is the possibility of inducing a change from the hypo- into the secondary and more serious hyperthyroidism. The best and safest medicinal thyroid preparations are the commercial tablets containing the 2 per cent or 5 per cent thyroid nucleoprotein material. This, unlike the common tablets of the entire dried gland, often called "thyroid extract," is practically non-toxic or harmless, and can be used with advantage in all debilitated or asthenic conditions.

A failure in the ovarian functions results in disturbances which are much like those following a failure in the thyroid, and so the product of the ovarian interstitial cells which act constantly, and of the corpus luteum which is present and acts intermittently, apparently exert a "drive" influence like the product of the thyroid. All of these endocrine glands, when defective, impair the general health and so affect the nutrition of the teeth. But it simplifies the understanding of this complicated problem to remember that only thyroid and, possibly, adrenal or ovarian feeding have any beneficial influence. The best preparations of these glands are probably their nucleoprotein materials.

Alfred F. Hess, M.D. (New York City): Dr. Gutman has presented this subject from a broad point of view. As Dr. Rogers has said, the paper is difficult to discuss, not only because it is very broad, but because the subject is in a very chaotic state. Dr. Rogers has told you what we know about these glands. In regard to the teeth, we know that in pituitary diseases there is some change: an enlargement of the teeth,[2] and a separation of the teeth and enlargement of the jaw. In animals there is a change in the teeth when the parathyroids are affected. If you remove the parathyroids in a rabbit there results not only the tetany, as has been mentioned, but the teeth become carious also. When it comes to the thymus, the adrenals and the thyroid, it is very difficult to say whether or not they have much to do with teeth, or are of particular interest to the dental profession.

This is such an interesting subject, and so open to the sweep of the imagination, that we must be very careful that we do not lead ourselves on from a few simple things we know to large deductions. In that way it is very similar to the vitamine question with which I have been associated for some years. We know there are vitamines definitely, and in increasing numbers. Physicians are ascribing all sorts of ills to the lack of vitamines, but we do not know to-day whether many people are affected in New York City by the lack of vitamines. We do not know whether it has very much to do with dental caries. It is true, if you take a guinea pig and deprive it of the anti-scorbutic vitamines, it will develop carious teeth in addition to the scurvy; but that guinea pig has received hardly any of these vitamines, and the question comes up as to how many of us are living without a sufficiency of vitamines. We must distinguish between the purely scientific aspect of the subject, and the practical and clinical.

As regards the intake of calcium, it is very necessary that the pregnant woman and the child should get sufficient calcium. The calcium supplied comes mainly in the form of milk, cheese, green vegetables, and in the cortical part of the cereals. It is necessary that the mother and the child should get these. However, we do not know when the mother and the child get enough calcium. I have interviewed very many mothers in New York City, and they tell me that while they are pregnant and nursing their babies, they take about a quart of milk a day. They may take insufficient green vegetables, or too much tea or bread, but most of them know enough to take a quart of milk a day, which should supply sufficient calcium. Recent studies have shown that the phosphate metabolism is more important in the

[2] This statement is based on insufficient evidence and must be considered as erroneous until more convincing proof is produced. (*Editor:* First District Dental Society of the State of New York.)

development of rickets than the calcium metabolism. In the blood of children that have rickets, it is peculiar that the calcium is almost normal. Since the earlier studies of rickets about twenty-five years ago, attention has been directed to the calcium. It had never been considered that the main salt was the calcium-phosphate. The main thought was directed toward the calcium, but not the phosphate. The phosphate is invariably sub-normal. If you give something to cure rickets—a specific, such as cod liver oil, the calcium may remain unchanged, but the phosphate comes up to normal. We should be particularly careful not only that the mother and child should have sufficient calcium, but that they should have sufficient phosphates; and these are contained largely in milk and cheese and eggs. However, we know that the countries of Central Europe were deprived of these things during the war; nevertheless, so far as I can learn, there has not been any great increase of rickets over there and certainly no great development of osteomalacia. There was evidence of malnutrition; but in Germany, where there was a lack of phosphates, there was no notable increase in the development of rickets.

From a therapeutic point of view we cannot consider the endocrines. We cannot say that all women who are pregnant, or all children, should have gland extracts. We can see that they have sufficient milk. The question of vitamines is of importance and it is to see that they have sufficient of the fresh foods.

It seems to me the great opportunity for a Society like this lies not in the investigation of endocrines, which must be carried out for the time being by the workers in the laboratory—they must tell us more about the facts, working with lower animals—but in the study of carious teeth in different countries. What is the condition of the teeth in China and India and Africa, and in countries where they live on peculiar dietaries? What is the effect of certain diets? In certain parts of India there are people who do not eat meat. In Africa I understand the colored people eat a great deal of meat. In China they eat a large quantity of rice. There are statistics but they are very unreliable, and it seems to me if reliable statistics could be gathered, we could find out better from them than from individuals—although individual cases are interesting—the relationship of infection, or malnutrition, or diet to carious teeth, which, as Dr. Gutman has said, is one of the great problems of civilization to-day.

Herman E. S. Chayes, D.D.S. (New York City): I think it will be conceded by the membership of this Society present this evening that the essay and the discussion of it will be of far-reaching benefit to the dental pro-

fession. It will serve again to direct our attention to the pertinent fact that real dentistry does not consist of repairing dental defects, restoring missing teeth or cleaning the teeth of school children, though all the foregoing are essential expressions of the profession, but rather of the initiation of activities which will enable us to bring forth a generation devoid of such constitutional digressions as make for decrepitudes which invite dental destruction. It speaks well for the members of this society that they are interested in this subject, for it shows a realization on their part that the means at hand have proved inadequate to accomplish the results they desire and that they are ready to seek, consider, and test other means for the purpose.

The difficulty of our position as dentists must not be lost sight of. Our training, our schooling, our environment and all our acts have always tended to circumscribe our vision and hinder our progress. I ask the essayist and the discussors of this essay to credit us at least with a receptivity of mind which, in view of our previous training, should strike the physicians as more than ordinary.

The subject of the endocrines in relation to the evolution of a perfect dental appenage is not new to us as dentists, no newer to us from our viewpoint than to physicians from theirs. We have been hearing and reading about it for quite a few years but it must be justly said that the greater part of the information has been vague, incoherent, nebulous and to our minds, at least, not clearly understandable. It may be that this has been due to some extent to a lack of medical education, but I have found that the greatest degree of misunderstanding of this subject manifests itself among those of us who have both the medical and dental degrees, and that "mere" dentists were more ready to receive this new knowledge than "mere" doctors. This much to explain and condone our laxity as a profession. Now, what about the subject itself?

How shall we dentists go about instituting this constitutional pre-natal and post-natal treatment in our patients? Shall we leave it wholly to the physician who admittedly knows not very much about it himself (I am speaking of endocrine physiology and pathology); or, shall we, scarcely understanding human physiology as it is, attempt to master this ultra-physiologic problem by acquainting ourselves with what literature we may be able to command and by training ourselves in clinical observation in a detailed and thorough manner? If we decide to leave our patient's constitutional endocrine dental well-being to the physician, which shall be our choice? The allopath, homeopath, naturopath, osteopath, the vibrotheraputist, the physico-mechano-therapist, the psychoanalyst, herbo-

therapist, the radio-therapist, or the mental healer? We cannot decide, we feel that we are confronted by a dyshormonism in the medical profession itself which makes it impossible for us to decide. It is clear that some simple way must be found to make us understand this endocrine problem, which we are willing to admit holds important and beneficial consequences for the well-being of the dental appenage of our present and future patients. From the mass of literature at our command, we can by patient perusal and study gather some few definite facts. From scattered parts we can assemble an articulated skeleton upon which to fit whatever findings we may make by observing our patients.

I wish here to caution my confrères against the careless and indiscriminate administration of the endocrines, and also against the administration of large doses of these agents. Here it is not a question of quantity but wholly of quality. We must also consider the established fact that rarely, if ever, is only one of these glands involved. As Dr. Joseph Fraenkel used to put it: "There is nothing monocausal in pathogenesis." These glands appear in the embryo in the following relation:

Thyroid and Thymus.—Quality, motion and equilibrium.

Pituitary.—Bulk, disposition, psychoses and periodicity.

Adrenal.—Energy-substance and form through thyro-pituitary influence.

Gonads.—Creative through pineal and thyroid, and procreative through pituitary and adrenals on terrestrial plane.

Now, it will occur to you that there must be a reason why the glands appear in this rotation, and there is. Most of you are familiar with the ceremony which the knights of old used to perform during their adventurous journeys in their search of new lands. As soon as a new island or continent was discovered, the fortunate explorer would put to shore and with solemn ceremony and impressive seriousness take possession of the territory for his particular king, or emperor. It is very much the same with the embyro. The thyroid and thymus immediately upon formation assume a directing influence over the secondary metabolic expression in the embryo and become influential in the formation of other glands. The motile quality of the embryonic tissues depends wholly upon the thyroid and from this gland a hormonic content is deposited in all the glands as they form. Thus the pituitary has a thyroidal content and so has the adrenal; on the other hand, the pituitary has an adrenal and gonadal content, and the adrenal has a pituitary and thyroidal and gonadal content. Thus you see that everything that is, is in everything and all things are in all. For this reason we make the statement that these glands are interdependent in their action and one cannot be disturbed, inhibited, or augmented without affecting all the other glands to some extent and bringing about a general pathogenesis.

Ewin Waller of England, in his book on "Thyroid and thyroid therapy," reports a great number of cases of dental decay or dental cachexia which are remarkably influenced for the better by thyroid administration. Some experiments carried on at the Forsyth Institute made clear the remarkable influence of the hypophyseal body on the formation of the dental apparatus. My own experiences and experiments already referred to and reported show that, when it is possible to read carefully the constitution of the patient, the proper endocrine remedy will act with remarkable specificity and speed. When the pathogenesis has become well established and is deep-seated and complex, it becomes difficult to decide which of these endocrines would be best suited to the case and often a pluriglandular extract may be employed. We must be prepared for disappointments, for we are neophytes in this work and adeptship is not easy to acquire. If the physicians will eliminate their own dyshormonism and agree as to which school we had best learn from, we dentists will feel under still greater obligations than we already are.

H. J. Kauffer, D.D.S. (New York City): Dr. Hess said it would be well to make a study of the teeth of the different nationalities. That is being done at Ellis Island, and we find that the most perfect teeth are among the Portuguese. The Portuguese are frequently found to be sailors. Among those sailors who have been at sea for two or more years, there is as much decay and the teeth are in as poor condition as of the average sailor of other nationalities. Although the Portuguese starts out with perfect teeth, when he is taken out of his native environment, whether it is due to a change of diet, or the sea, or something else, his teeth decay very rapidly. On the other hand, in the Chinaman we rarely find a decayed or missing tooth, and the Chinaman also frequently goes to sea. I have examined several hundred. There are many sailors among the Chinese, and we very rarely find a decayed tooth in a Chinese seaman. The Chinaman continues his home diet. It is cheap for the ship to supply him with rice, and he continues his accustomed diet.

L. M. Waugh, D.D.S. (New York City): I have heard Dr. Gutman address dental audiences on other occasions, and have always been agreeably surprised that a physician should have so much knowledge concerning dental matters. If I understood properly, it was stated by the essayist, and concurred in by Doctors Rogers and Hess, that the teeth grow in size, after eruption. Students of dental embryology know that the size of the crown of a tooth is as large as it ever will be quite a time before it peeps through the gum; and that after eruption, it cannot grow larger. The tooth moves farther out of the gum as it takes its place, but the size of the crown cannot increase after eruption, regardless of the action of the pituitary or other endocrines, or as the result of any other influence.

Dr. Gutman (in conclusion): Permit me to express to all of you my deep appreciation of the privilege of speaking to you on a subject in which I am very much interested and my sincere gratitude to the gentlemen who have so kindly discussed my remarks.

I have often noticed that, when medical and dental men get together, to hear discussions concerning endocrinology coming from what we might call first-class sources, i.e., men who have been interested in the subject for many years, a great deal is said about things which are not known and about many differences of opinion which exist in regard to apparently simple questions. Can the average practitioner carry away from such discussions much more than vague ideas and disappointment? It may be said without fear of contradiction, I think, that the cause of much of this difference of opinion comes from different interpretations of phenomena observed in animal experimentation; many kinds of results and deductions may be obtained. If endocrinologists gave more attention to clinical evidences and confined themselves less exclusively to the findings in animal experimentation, they would, I feel sure, come to more uniform conclusions. What I have related this evening is not based upon experimental work; I have but few facilities for animal experimentation. Most of what I have told you was gathered from clinical experience obtained in my daily work. We are not privileged to say what one or another gland does until we have studied their pathology in connection with the symptoms they produce, by abnormalities in their functional activity. Only when this has been done can we come to conclusions concerning their normal functions. By the footprints on the sand we can tell whether a dog, bird, or man crossed there; by certain signs and symptoms which occur in disease of the endocrine glands we may discover what their work was during health.

Acromegaly has been mentioned here to-night and some of its features discussed by the gentlemen present. I shall not forget the sight when a number of years ago, during my stay in Vienna, Professor Wagner exhibited at the Allgemeine Krankenhaus Klinic some fifteen or twenty pituitary patients seated all at one time on the platform of the lecture room; patients who had been acromegalics and were now shown after their hypophyses had been removed. Most of them had their photographs before the disease had affected them; all had photographs of their period of acromegaly. I could not but be impressed by such a sight nor could I escape the conclusion that their pituitary gland must have been in close connection with or had been the cause of their peculiar state. In these circumstances it seemed perfectly justifiable to assert that the pituitary gland had something to do with the size of the hands, feet, jaws, teeth and other morbid manifestations.

Even if experiments upon animals do not reproduce such conditions; we need not doubt their origin in the sick man. The clinic teaches real facts. Disease is nature's experiment, and its consequences should be rated as more and not less valid information than the information drawn from experiments planned and carried out by man.

When I mentioned the fact that the pituitary has some connection with the size and position of the teeth, I said this because of observations made in cases of pituitary disease, acromegaly showing one type of teeth, and the disturbances of the posterior lobe showing another type. There are no other diseases, so far as we know, in which the separation of teeth and the changes in the lower jaw occur as they do in pituitary affections. So characteristic are these features that if you should tell me, or Dr. Chayes or anyone else accustomed to classify patients from the endocrine standpoint, that a certain person is of the pituitary type, we might be able to describe his teeth and other features even without seeing him; for the teeth, like the other organs, are characteristic of each constitutional make-up. We are accustomed to see these coincidences in our every-day work. Indeed, I do not care to make a pathologic diagnosis without first determining the endocrine type of the patient, as this is an important factor in determining the nature of the pathological change which may occur in a given case. I have been able to differentiate the gastric from a duodenal ulcer by my knowledge of the patient's endocrine type; to detect the presence of a neoplasm without seeing the patient except as I saw him through a description of his features. Analysis of a patient's case becomes easier when we recognize the main tendencies of endocrine behavior which were present in his normal state.

As to the question whether the enlargement of the teeth in pituitary disease is due to an actual increase in the number of elements constituting the organ or to the hypertrophy of certain elements, I am not able to say. I do know however, that in the enlargement of other organs such as the heart, which may reach two or three times its normal size, this enlargement is due to the hypertrophy of the individual fibres and not to increase in the number of muscles. We are born with a certain number of alveoli in the lungs; these are stretched and enlarged in normal growth and in emphysema—in disease—but are never increased in number. Perhaps this may also be true of the pituitary acromegalic teeth; they become larger, most probably not because of an increase in the number of cellular elements but more probably because of an enlargement of each element and increase of the intercellular substance.

Regarding endocrine drug administration and its frequent failures, I should like to say that it is fatuous to expect success with the material now

available. I believe that most of the good results obtained to-day are accidental. What can we expect from dead tissue? We know that the hormones so far isolated are extremely powerful in their action in the living body. The minutest quantity of adrenalin, one part in several millions, is sufficient to restore contraction in a heart at a standstill. Other hormones are active in almost infinitesimal amounts. That thyroid material has given the best results is due to the fact that it has been most studied and that the conditions in which it is applied are most correctly diagnosed. I did not speak about therapy. I only wish to call your attention to prophylaxis and to recall to you that this is not limited to the cleansing of teeth or the prescribing of a proper kind of brush or tooth paste. There are more important factors in prophylaxis; and, if you wish to control these, you must start during early infant life. If there is not good material in the mother to build good teeth in the child, these cannot be properly formed. If calcium is the material lacking, then common sense will tell you that the calcium metabolism in the mother must be righted. You cannot determine by looking into the pregnant mother's mouth whether she has a normal calcium balance or not; you must therefore go somewhat deeper in your study of her constitution.